University of Southampton

Faculty of Arts and Humanities

Modern Languages

Receptive Recognition and Productive Written Use of Technical and Sub-technical Vocabulary by First Year Undergraduate Students of Medicine in the UK

By

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Thesis for the degree of Doctor of Philosophy in Applied Linguistics in English Language Teaching

July 2022

University of Southampton

Abstract

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iPhD Doctor of Philosophy

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First-year medical students Learning and Teaching Resources (LETERs) include a considerable amount of discipline-specific vocabulary for English for Medical Purposes (EMP) such as the technical and the sub-technical. The former refers to the specialised vocabulary used only in a specific field (Chung and Nation, 2004, Coxhead, 2013), while the latter refers to the shared vocabulary amongst academic disciplines (Baker, 1988; Hsu, 2013). First year medical students' familiarization with the technical and sub-technical vocabulary typically occurs from reading LETERs during their coursework and was cited as a contributing factor towards their study-related stress and burnout (Sinclair, 1997; Boni et al., 2018). The density of Learning and Teaching Resources (LETERs) as part of first year medical students' coursework in terms of technical and sub-technical vocabulary as well as the receptive and productive vocabulary of L1 and L2 medical students in their first year is an area that has been unexplored by scholars in the field of EMP. Thus, the aim of this study is to look into the technical and sub-technical vocabulary of medicine from multiple perspectives such as its density in medical texts and examine the recognition and production of technical and sub-technical vocabulary from a total sample of 115 (L1 and L2) first year medical students in the UK. In order to collect the language data, two corpora of medical language were compiled as part of this study: the Medical Receptive (MEDREC) corpus of 2,097,627 running words based on 6 types of LETERs and the Medical Productive (MEDPRO) corpus of 209,160 running words of 115 written samples. Findings from lexical density analysis on LETERs suggests a propensity towards a higher degree of usage of technical vocabulary and results from the Receptive Recognition (RecRec) Task indicate a significant progress by the end of the initial semester in both technical and sub-technical vocabulary. In addition, analysis of productive vocabulary usage suggests that the sub-technical vocabulary was denser in medical students' writings, which is inversely proportional in relation to the vocabulary that medical students were introduced to from LETERs texts with L1 or L2 English having a minimal effect on findings. The original contribution of this thesis is to fill a gap in the current literature on the complexity of disciplinary vocabulary used in LETERs and the development of the RecRec Task suitable for new medical/EMP students. In addition, it is one of the first experimental studies in medical English, which involved both L1 and L2 medical students' receptive and productive vocabulary skills.

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Research Thesis: Declaration of Authorship

I:

Print name:	*Stavroula El. Gkarampliana Adams*

Title of thesis:	*Receptive recognition and productive written use of technical and sub-technical vocabulary by first year undergraduate students of medicine in the UK*

I declare that this thesis and the work presented in it is my own and has been generated by me as the result of my own original research.

I confirm that:

1. *This work was done wholly or mainly while in candidature for a research degree at this University;*
2. *Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;*
3. *Where I have consulted the published work of others, this is always clearly attributed;*
4. *Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;*
5. *I have acknowledged all main sources of help;*
6. *Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;*
7. *Either none of this work has been published before submission, or parts of this work have been published as: [please list references below]:*

Signature:		*Date:*	*14/06/2022*

Acknowledgements

I would like to thank God Almighty for bringing me the inspiration, determination and patience to conduct the present study in an effort to contribute to the existing literature in the growing field of English for Medical Purposes.

Please note*:*

i)an editor/proofreader has **not** *been used at any stage of the construction of this study and I am fully responsible for the writing and the drafting of this PhD;*
ii) no financial incentive was received for this PhD research study.
I would like to thank Emeritus Professor Patrick Stevenson, my main supervisor from the beginning through to Chapter 4 of this PhD thesis. He was very encouraging throughout the time he supervised me and he offered useful and constructive suggestions and comments for improvement.

Then, I would like to extend my sincere thanks to Dr. Ying Zheng who became my second main supervisor towards the end of the present thesis, she offered substantial input and shared her expertise in statistics. She was always there for me any time I needed her help or advice.

I am also grateful to Dr. Anja Timm, who offered her views from the medical faculty perspective during our supervision meetings and provided me with invaluable information regarding the way(s) to approach the faculty of medicine.

I am indebted to Emerita Professor Ros Mitchell who volunteered her expertise in the design of my thesis at the beginning of the thesis and believed in my skills and me during my first steps into this research.

I am also grateful to all anonymous medical lecturers and students who took part in the present research study and volunteered their time and insights regarding their learning journey of disciplinary vocabulary before, during and after lectures.

This PhD was a path during which I changed and evolved in many levels both as a person and as a researcher. I suspended my studies during my pregnancies and I combined studying with full childcare for a number of years. As a mum of two, I lived away from my own family and towards the end of my studies, COVID19 made the situation harder adding home-schooling, nursing, isolation and *financial difficulties into my daily routine. Parenting and PhD writing was something I have never done and never thought I could do in my life. My time available was used to the extent possible to write the present PhD thesis.*

A PhD is a special experience for each candidate and it comes with a number of realizations with regard to people and their impact during this long journey. People like my parents, Eleftherios Gkaramplianas and Sotiria Karvouna Gkarampliana were always in my heart as their words of encouragement to chase my dreams echoed in my mind throughout the period of my candidature. My brother, Christos Gkaramplianas and Efthymia Trapeza were supportive and there to cheer me up and Andria Zorpa always offered a friendly ear during good and bad times. In addition, Mrs Angela Sentza, who is a childhood teacher of mine and inspires me to achieve to this day so I feel privileged to have had her by my side during this long journey. Furthermore, my parents-sisters-brothers-uncles-aunts-cousins-in-law have shown me with their example that there is more to life than studying. Moreover, my husband, Ian Adams, was a rock to me. We met and married at the beginning of my PhD course and he has supported me throughout my candidature by listening and offering me plenty of encouragement to move on with my work during my long days and nights. As I was reaching the end of my candidature right before my Viva exam, he became a stay-at-home father, he took care of our children (aged 1 and 4 years old at that time) and our household and tried to cook healthy meals to feed our family. His presence at home was very helpful as it allowed me to concentrate on finalising my work. My thanks extend to my two children: my son, Fred Eleftherios Alexander Adams, and my daughter, Amy-Olympia Sotiria Aphrodite Adams, who arrived during my PhD journey, filled my life with joy and laughter, and surprised me with their intelligence, determination, creativity, and kindness. It is thanks to them that I had the great pleasure to feel the joy of motherhood during this exciting but busy time in my life helping me realize how quickly time flows when we live life to the fullest. The individuals and family members mentioned here encouraged me to be patient and think positively at all times. It is to all of them that I wish to dedicate my work!

I would also like to thank my anonymous Viva Examiners who made my Viva a very constructive and pleasant experience for me. Finally, I would like to thank my readers for the time they spare reading through my work. It is my hope that it may become a source of inspiration for continuing research in the future.

List of Abbreviations

For economy reasons, a number of words used throughout the thesis are abbreviated. The reader is kindly suggested to refer to the following list to clarify the abbreviations used throughout the thesis.

- *ACE= Australian Corpus of English*
- *ASWL= Academic Spoken Word List*
- *ATP=Adenosyl TriPhosphate*
- *AVL= Academic Vocabulary List*
- *AWL= Academic Word List*
- *BA= Barchelor's*
- *BNA= Basel Nomina Anatomica*
- *BNC=British National Corpus*
- *cAMP=Cyclic Adenosine Monophosphate*
- *CATSS= Computer Adaptive Test of Size and Strength*
- *CEFR= Common European Framework of Reference*
- *COCA= Corpus of Contemporary American English*
- *COPD=Chronic Obstructive Pulmonary Disease*
- *CRs= Case Reports*
- *EAP=English for Academic Purposes*
- *EAP SL=English for Academic Purposes Science List*
- *EEWL= Engineering English Word List*
- *EFL= English as a Foreign Language*
- *EMP= English for Medical Purposes*
- *ERGO= Ethics and Research Governance Online*
- *ESL= English as a Second Language*
- *ESP=English for Specific Purposes*
- *FA= False Alarms*
- *FLOB= Freiburg-LOB corpus*
- *FROWN= Freiburg-Brown corpus*
- *GE=General English*
- *GMC= General Medical Council*
- *GSL= General Service List*
- *HLDH=hepatolenticular degeneration*
- *HSWL= Hard Science Spoken Word List*
- *ID= Identification*
- *IELTS= International English Language Testing System*
- *IMG= Image*
- *IVP=Intravenous Push*
- *IW= Imaginary Words*
- *JPG= Joint Photographic Group*
- *LBs=Lexical Bands*
- *LETERs= Learning and Teaching Resources*
- *LFP = Lexical Frequency Profile*
- *LOB= Lancaster-Oslo/Bergen corpus*
- *L1=English as a first language*

- *L2=English as a second or foreign language*
- *L3= third language*
- *MA= Master's*
- *MAVL= Medical Academic Vocabulary List*
- *MAWL= Medical Academic Word List*
- *ME=Medical English*
- *MEDREC=Medical Receptive Corpus*
- *MEDPRO= Medical Productive Corpus*
- *MLAT= Modern Language Aptitude Test*
- *MRAs= Medical Research Articles*
- *MVL= Medical Vocabulary List*
- *MWL= Medical Word List*
- *MAWL= Medical Academic Word List*
- *MAWLcc= Medical Academic Word List for Clinical Cases*
- *NHS= National Health Service*
- *NLP= Natural Language Processing*
- *OCR= Optical Character Recognition*
- *ORS= Online Resources Sub-corpus*
- *PAWL= Pharmacology Academic Word List*
- *PBL= Problem Based Learning*
- *PDF Format=Portable Document Format*
- *PiPs=Pathology Interactive Practicals*
- *PIS=Participants Information Sheet*
- *POS= Part of Speech*
- *PVLT= Productive Vocabulary Levels Test*
- *PVST= Productive Vocabulary Size*
- *RT= Reaction Time*
- *SL=Sub-List*
- *SPSS= Statistical Package for Social Sciences*
- *SSWL= Soft Sciences Word List*
- *TCM= Traditional Chinese Medicine*
- *TOEFL= Test of English as a Foreign Language*
- *TS=Textbooks Sub-corpus*
- *UK= United Kingdom*
- *UKCAT= United Kingdom Clinical Aptitude Test*
- *VLT=Vocabulary Levels Test*
- *VP= Vocabulary Profile(r)*
- *WPC= Whole Paper Corpus*
- *WWC= the Wellington corpus of written New Zealand English*
- *WWII= Second World War*

Chapter 1 Introduction

1.1 Research Background

English for Medical Purposes (EMP) is a major area of interest within the field of English for Specific Purposes (ESP). EMP emerged after the end of the World War II when English became the international Lingua Franca of scientific fields (Jablonkai, 2020) such as medicine (Benfield and Howard, 2000; Crystal, 2013; Ferguson, 2013; Salager-Meyer, 2014). EMP involves the instruction of the type of language variety that is necessary "for doctors, nurses, and other personnel involving an utilitarian purpose, an identifiable goal and contributing to the successful performance of work for the optimum effectiveness of medical training" (Maher, 1986:112). In this thesis, the terms Medical English (ME) and English for Medical Purposes (EMP), will be used interchangeably to refer to the kind of language that is shared amongst members of the medical community in order to communicate in medical practice and education settings with other experts or patients in line with Sinclair (1997; 2020). In addition, medical students fall into two broad categories: students of EMP/ME who speak English as a first language (L1) and students of EMP/ME who speak English as a second or foreign language (L2) (Cook, 1992).

The area of EMP has received considerable attention with linguists examining its idiosyncratic features. The emerging need for more EMP courses for speakers of languages other than English (L2) resulted in a number of research studies aiming to examine features that are typical of the medical genre specifically for L2 instruction leading to the production of EMP preparatory textbook materials (Munby, 1978; Schutz and Derwing, 1981). Although learning materials aimed at teaching vocabulary to EMP students, it was noted that ever since the institutionalisation of EMP learning and teaching models of EMP, vocabulary was not given adequate attention in textbooks (Maher, 1986). Since then and until now there is still a lack of empirical research studies in the area of learning the EMP vocabulary, which could advance our understanding of medical students processing of EMP vocabulary. A notable distinction of EMP vocabulary is the technical and sub-technical vocabulary used in the medical discipline. According to Gardner and Davies (2014) "No one seems to dispute the fact that discipline-

specific (technical) words are essential to academic understanding" (2014:310) and their link with "knowledge of the subject" (Gablasova, 2014: 976). While it has been considered that technical vocabulary can be acquired by students over the course of their medical studies (Sinclair, 1997; 2020), it has been claimed that it is often the sub-technical and infrequent vocabulary in general English that poses more challenges particularly to L2 learners (Hsu, 2013; Ferguson, 2013). For instance, Nation et al. (2016) claimed, "The sub-technical (academic) vocabulary is often not well known, and is not salient in academic texts making it less likely to be learned than the technical vocabulary. It thus needs attention." (2016: 148). As can be seen from the above both the technical and the sub-technical vocabulary are key in disciplinary fields such as medicine. Despite the key role of technical and sub-technical vocabulary in EMP texts, such as learning and teaching materials (LETERs), there seems to be a gap of knowledge in the literature as regards to the type(s) of vocabulary medical students can effectively recognize and produce at the beginning of their academic studies. Thus, the present study aims to focus on these two types of vocabulary with reference to receptive and productive vocabulary.

Becoming familiar and using the vocabulary of a scientific discipline is an empowering skill for university students. This project was conceived during my time abroad teaching English for Academic Purposes (EAP) to prospective BA students who would enrol in disciplines including medicine at the end of the course. After a year of teaching EAP in the department, some of my highest achieving students who entered the faculty of medicine complained that the type of English they encountered in medical texts was very difficult, extremely demanding and that the vocabulary preparation I offered them while following the curriculum was of little benefit to them during their medical degree studies. They brought me samples of their learning and teaching materials texts and we went through them together. It was disappointing to see that their claims were real and despite their high achievements in the EAP program, they knew limited EMP vocabulary to comprehend their resources effectively during their initial year of medical studies. This brought a lot of stress and worry about their future prospects. Years later, and upon arriving in the UK for my Doctoral studies, it happened to meet a number of first year British medical students. They sadly narrated similar experiences to the students from the foreign institution. I wondered whether I could use my linguistics background to conduct a linguistic *study on medical students' vocabulary from the learning resources available and examine the vocabulary of medicine and how much of it medical students were familiarised with receptively or could use productively. Upon researching about vocabulary in the area of EMP, I realised that there was a gap in experimental research on vocabulary studies involving medical students. Most of the linguistic EMP studies involved: a) the investigation of the doctor-patient communication in clinical practice and b) the pedagogy for learning and teaching practice (Ferguson, 2013). The pedagogy-oriented studies involved examination of medical text features of specific genres often accompanied by a suggestive wordlist. Interestingly, pedagogical studies mainly analysed medical vocabulary features without extending them into more empirical studies; e.g. focusing on the medical students who need to acquire this vocabulary as part of fulfilling their academic requirements. The overwhelming majority of research studies focused on L2 medical students despite claims that L1 medical students found disciplinary vocabulary equally challenging during their first year of studies (Sinclair, 1997). One reason for the lack of such research relates to involving medical students ethical application procedure requirements from University Medical Faculties, as it was the case for the present research study, which is sensitive, time consuming and complicated, to say the least. In addition, the heavy coursework that medical students undertake is often insurmountable, unlike other undergraduates. As Cohen et al. (2013) correctly point out: "medical students' workload is considerably higher than that of many other students at university" (Cohen et al., 2013: p. 6), thus, making it particularly challenging to recruit dedicated participants to conduct viable experimental vocabulary studies in the area of EMP.*

1.2 Studying Medicine in the UK

Medical faculties in the UK follow a set curriculum in line with the learning standards set by the UK's General Medical Council (GMC). In order to achieve the same learning outcomes across the UK, all British medical faculties should comply with the GMC curriculim (Timm and Polack, 2016; GMC, 2018). In this way, all UK-based medical schools deliver programs of similar standards with a view to guarantee the same level of education to all medical graduates who, in all likelihood, will become members of the UK's National Health Service (NHS), which aims to provide quality healthcare services across the United Kingdom. The *context of the present study is a British faculty of medicine which for the purposes of this study remains anonymous. At the time of the research, medical studies typically took approximately five years to complete. During the first two pre-clinical years of academic studies medical students received a lot of theoretical instruction through lectures, tutorials and practicals. Learning and Teaching Resources (LETERs) are a significant source of medical education in preparation for the follow-up clinical years. LETERs introduced medical students to important medical information, they supplemented lectures, practicals, tutorials and they were recommended for medical students' independent study. Through LETERs, medical students had the opportunity to introduce themselves to the vocabulary and expression that is typically followed in specialised areas of medicine such as "anatomy, biochemistry, pathology, physiology, pharmacology, the social sciences and public health medicine" (University of Southampton, 2015:134). The clinical years would begin from the third year onwards, where medical students would be expected to conduct a research study in their preferred medical sub-discipline and they would also be expected to "work in research labs, hospital wards, general practice and the community" (University of Southampton, 2015:134). During their fourth and fifth year, most medical students would become members of health professional teams "on a developing apprenticeship" (University of Southampton, 2015:134). The initial semester of year 1 in medicine acts as a transition from secondary to higher education for medical students and its role is to promote scientific knowledge and provide an orientation to the delivery of medical education by familiarising new medical students with the teaching context and ways to use medical resources. The learning and teaching materials as well as lectures follow the conventions of the medical genre which is often not taught prior to admission in medical studies at college/high school or equivalent.*

At the time when the present study took place, medical students in their initial semester of studies would spend full days at the faculty with lectures, tutorials and practicals. Lectures would take place in large amphitheatres with the lecturer standing at the front and a large screen behind him or her presenting the topic on lecture slides. The faculty would appoint some key lecturers who would deliver sessions regularly and would invite specialists from a number of medical fields to give lectures on topics that go in line with the curiculum and their area of expertise. Thus, medical students would be introduced to a number of different *concepts by different presenters each time almost on a weekly basis. In this way, medical students were introduced to a variety of materials in their LETERs and would have a chance to ask questions during the sessions. In addition, medical students would attend tutorials in the form of group seminars with a limited amount of students where they would be prompted to use their medical knowledge to discuss case study medical scenarios. Finally, they would attend dissection practicals where they would explore the human anatomy through focus on different human body parts.*

As far as the productive use of disciplinary vocabulary in writing is concerned, an abundance of specialised vocabulary in medicine could be a reason for the inclusion of the appropriacy of medical language as part of academic evaluation. For instance, one of the faculty's marking criteria that were related to Coherence and Clarity was included in the grade descriptors of the university where the study took place. The use of "appropriate terminology" for a successful academic paper, "inaccurate use of terminology" for a fair paper or "inappropriate use of terminology" for an unsuccessful paper were highlighted (University of Southampton Faculty of Medicine Grade Descriptors, 2014: 1, see Appendix A) were amongst them. This indicates that in the context where the present study took place, medical students were marked down or failing the course when the vocabulary of their discipline was not used accurately or appropriately in their assessed written essay. Obviously, the marking criteria assume that students would produce specialised vocabulary, however, the absence of specialised vocabulary from written texts was not considered as a marking criterion, which means that students would not increase their marks if their essay lacked specialised words.

Upon following my medical student participants in all learning environments during their initial semester, I was finishing my days feeling mentally exhausted from the information overload. I couldn't help compare their timetable with my old timetable when I was a first year undergraduate student in Linguistics. I felt a great degree of admiration for the sheer amount of workload medical students have at the beginning of their BA degrees. As far as the independent study of their learning materials is concerned, it would take place the same afternoon or at night, according to some of my participants. Many of them would keep studying on weekends and holidays to catch up and their time available outside *the school was very limited. This was the reality for a number of first year medical students whom I got to know as part of this project. Given that the volume of coursework and curriculum regulated by the GMC is the same across every medical school in the UK, the reality described here reflects the life of a considerable number of first year medical students across the UK.*

1.3 Rationale of the Thesis

As discussed in the previous section 1.2, medical students had a busy timetable during their initial semester of studies and following them in their disciplinary sessions was an overwhelming experience for the researcher. In the same way, medical students might have been overwhelmed too. Lamentably, it has been observed that medical students experience burnout during their initial year of medical studies (Boni et al., 2018) to a higher degree compared to students from other disciplines (Shanafelt, 2012). A contributing factor associated with their burnout relates to coursework (Wani and Qazi, 2019; Tariq et al., 2020). As part of medical students' coursework, studying the Learning and Teaching Resources (LETERs) before or after the end of their lectures was part of their reality until they complete the course and pass their exams at the end of each term. As part of medical LETERs reading, "Medical students read hundreds of pages on a daily basis. They come across unknown vocabulary often, but rarely have time to consult a dictionary for every word." (Zrníková and Bujalková, 2018: p. 15).

It becomes clear that part of the coursework involves learning of new disciplinary vocabulary in line with Sinclair (1997). In addition, it has been recognised that competence in specialised vocabulary is associated with sufficient understanding of a field of study (Gablasova, 2014b). While EMP vocabulary focused on L2 subjects, the L1 students' needs on EMP vocabulary have been overlooked to this day possibly due to the perceived advantage that L1 medical students have to own English as a native language. This is contrary to Coxhead's (2011) postulation, which argued that disciplinary vocabulary, even if it is in one's first language, requires subjects to utilize similar cognitive mechanisms as they would when learning a second or foreign language. At a later work, Coxhead (2018) claimed that L1 medical students might also have the necessity to learn the vocabulary of the medical discipline. It is a challenging field of scientific study not only in terms of its volume of coursework but also in terms of the specialised *vocabulary load appearing in the Learning and Teaching Resources (LETERs) (Chung and Nation, 2003; Quero, 2015).*

The specialised vocabulary of medicine that students are required to familiarize themselves with from the beginning of their studies is complex and distinctive. Specifically, it received a considerable number of language loans from Greek, Latin and other languages such as French, Arabic, German, Spanish and Italian. An analysis of Dorland's Illustrated Medical Dictionary (24th edition) revealed that more than half of the medical vocabulary entries derived from classical languages such as Greek and Latin (Butler, 1980). Due to the prolonged existence and complexity associated with classical languages, it is not surprising that medical vocabulary, which is based on them to a significant degree, is challenging particularly to new students studying medicine regardless of L1 (Sinclair, 1997) or L2 background (Evans and Morrison, 2011).

Table 1. Sources of Medical Vocabulary. Source: Butler, R., F. (1980) Sources of the medical vocabulary. Academic Medicine, 55(2), pp.128-9, page: 128.

Sources of the Vocabulary of *Dorland's Illustrated Medical Dictionary* (24th edition)

Derivation	No. of Words Derived	Percent of Vocabulary*
Greek alone	28,325	58.50
Latin alone	10,540	21.77
Greek and Latin	6,410	13.23
Greek and other languages	446	.92
Greek and proper names	190	.39
Latin and other languages	235	.49
Latin and proper names	38	.08
English	1,411	2.91
Proper names	761	1.57
French	548	1.13
Arabic	289	.60
German	221	.46
Spanish	129	.27
Italian	51	.11
All other sources†	639	1.31

* The percentages total more than 100 percent because hybrid words are counted twice, once as Greek or Latin and once as another language.

† Less than 1 percent each.

This can be further illustrated in Table 1, which demonstrates that Medical vocabulary has rich derivational influences from a number of languages. As can be seen, the most influential language is Greek (58.50%), then Latin (21.77%), and a mix of Greek and Latin (13.23%). It becomes clear that Medical English has received an incredible amount of linguistic loans from classical languages as well as others. This supports Butler's (1980) study, which suggested that only 2.91% of the medical vocabulary entries derive from English. Thus, the languages outlined in Table 1 below and especially the classical ones may increase the effort that L1 and L2 learners make in order to learn ME given that they are not only learning words that encapsulate medical information about body parts or functions but they are learning word items from a number of different languages too.

In the same vein, Chung and Nation (2003) found that one in three words in an anatomy textbook is technical. This led Coxhead (2018) to acknowledge that the high degree of technicality encountered in medical LETERs, such as anatomy, implies a large vocabulary learning burden (see section 2.4 for further discussion). In addition, it has been claimed that in order to "achieve academic success, learners need to have good knowledge of both academic spoken and written vocabulary" (Dang, Coxhead and Webb, 2017:688).

The process of acquiring medical English vocabulary has often been described as a particularly demanding experience for both L1 and L2 medical students studying across the UK (Sinclair, 1997). In order to deal with this challenge, pre-clinical students tend to make a considerable effort to learn key medical vocabulary either in academic settings, such as lectures and using learning materials (e.g. textbooks), or in hospital settings, such as the hospital wards (Sinclair, 1997). In addition, it was claimed that acquiring the vocabulary of the medical discipline is a stressful experience for medical students:

> *"The psychological problems encountered by those in training are in part due to the acquisition of a specialist language that is utterly unsuited to dealing with internal mental events, let alone altering social aspects of doctors' practice" (Sinclair, 1997: 321-322).*

To this date, no substantial research was conducted on both L1 and L2 medical students learning of technical and sub-technical vocabulary using the same LETERs under the same learning conditions during their first semester of studies. The only source so far where L1 learners' vocabulary difficulties were recognised was Sinclair's (1997) longitudinal study of a group of native English (L1) medical students in the UK. Although Sinclair (1997) did not conduct a linguistic study but rather studied the psychology of first year medical students, he highlighted the area of vocabulary, which permeates all aspects of medical education. This area is the acquisition of the specialised vocabulary of the discipline, which was believed to be the most challenging for the group of medical students he followed.

> *"To tackle preclinical work, students need to learn the languages of the different academic disciplines in which Knowledge [i.e. medical scientific knowledge] is expressed (a point that is sometimes made explicitly in lectures), and exams in these subjects are to some degree assessments of students' proficiency in each discipline's language. Although doctors are not generally thought of as linguists, the acquisition of the various languages of medicine is a necessary and important part of their training." (Sinclair, 1997: 141).*

In the L2 context, the need to acquire vast amounts of vocabulary seemed to have led L2 medical students to find ways to improve their memorization techniques. As Roguj and Cizmic (2018) point out:

> *"at the very beginning of their medical education, students have to find best ways of memorizing a large number of anatomic terms that are presented along with illustrations in their anatomy course books, or by means of digital technology or cadaver - based instruction in their anatomy classrooms." (2018: 52).*

Furthermore, a need for the acquisition of specialised language has been advocated in a related field to EMP, which is English for Nursing, where disciplinary vocabulary has been considered as an integral part of identifying oneself as a health professional and as a member of the professional community (Bosher, 2011; 2013). The need for health professionals to share a common disciplinary vocabulary could justify the reason why lecturers and medical *consultants insist on trainee medical students to use standardised medical terminology (Sinclair, 1997). In addition, Nation (2016) further supported the claims above suggesting: "one of the most obvious and largest areas [of specialised vocabulary] is the vocabulary of medicine. Learning to be a doctor includes learning thousands of medical words that are essential to mastering the knowledge of the field." (2016:7).*

As can be seen in the discussion above, medical disciplinary vocabulary is very demanding and limited experimental research has been conducted so far. Although studies based on the analysis of the textual features were conducted on technical (e.g. Chung and Nation, 2003; Quero, 2017) and sub-technical vocabulary (e.g. Wang et al., 2008; Hsu, 2013; 2018), a limited number of studies looked into the technical and sub-technical vocabulary by means of involving corpora and medical students (e.g. Quero, 2015; 2017). A considerable proportion of EMP studies so far focused on L2 learners with no emphasis on L1 learners at a time when it has been postulated that medical studies involve the most demanding vocabulary compared to other scientific fields (Dang and Webb (2014). Considering Maxwell's (2013) suggestion that "nobody is a native speaker of Academic English" (p. 14), it is reasonable to assume that both L1 and L2 medical students may be introduced to disciplinary vocabulary for the first time through LETERs during their initial semester in year 1 and come to terms with the concepts it represents. In addition, most of the studies conducted in the field so far focused on medical texts analysis and produced long wordlists to assist Medical English instructors prioritise the vocabulary that medical students should learn first (e.g. Wang et al., 2008; Hsu, 2013; 2018). However, no academic research in the field has documented medical students' actual linguistic development over time nor examined the relationship between a basic word knowledge skill, such as receptive recognition, and written production. In addition, given that "medical students and health care professionals are increasingly faced with the need to have not only a passive but also an active command of professional English, an essential skill for their career" (Ripamonti, 2015: 125), there is no study to this day that looked into this need in first year medical students' writing. Taken together, there is a gap in the literature with regard to the density of technical and sub-technical vocabulary in a variety of EMP LETERs and it is unclear how much of this vocabulary first year medical students know or develop over time and use in writing during their first semester.

In light of the above, the aims and research questions of the present study are formulated and discussed in the following section, 1.4.

1.4 Aims and Research Questions

The main aim of the present study is to investigate first year medical students' technical and sub-technical vocabulary. By focusing on receptive and productive skills, this study intends to shed light on the density of received vocabulary from LETERs as well as medical students' receptive and productive technical and sub-technical vocabulary at the beginning and end of their initial semester of medical studies. The UK's medical faculty where the present study took place brought the opportunity to look into vocabulary, which Coxhead (2018) called "the building block" vocabulary (2018:105). It refers to the basic pre-clinical vocabulary of courses such as biology and chemistry. In light of this, the present study aims to provide a better understanding of the density of medical vocabulary used in LETERs and to examine the linguistic development of medical students' receptive and productive use of technical and sub-technical vocabulary (Chung and Nation, 2004) for both L1 and L2 participants.

Thus, the present thesis intends to address the aims outlined below.

1. *To examine the density of technical and sub-technical vocabulary in the Learning and Teaching Resource materials (LETERs) that medical students study as part of their subject knowledge.*
2. *To examine the receptive recognition of two typical kinds of vocabulary encountered in medical discourse: the technical and sub-technical vocabulary at the beginning and end of their initial semester of studies.*
3. *To investigate medical students' degree of technical and sub-technical vocabulary at productive usage.*
4. *To examine the effect of participants' linguistic backgrounds (L1/L2) on the technical and sub-technical vocabulary performance on the receptive and productive task.*

Based on the aims outlined above, the following four research questions were formulated for the purposes of the present study.

1. ***What is the lexical density of technical and sub-technical vocabulary in Learning and Teaching Resources (LETERs)?***

This research question aims to provide information with regard to the lexical density percentage proportion of technical and sub-technical vocabulary in Learning and Teaching Resources (LETERs) that medical students encounter during their initial semester of academic studies in medicine. Examples of LETERs are resources such as lectures slides, medical textbooks, pips, tutorial notes, computer practicals and e-learning resources. By looking into density, it can be possible to gain more in-depth insights as regards to developing a better understanding of how dense the technical and sub-technical vocabulary is in LETERs.

2. ***To what extent are medical students able to recognise the technical and sub-technical vocabulary appearing in their disciplinary Learning and Teaching Resources (LETERs) at the beginning and end of their introductory semester in year 1?***

The second research question focuses on bringing more evidence from medical students regarding their capacity to recognise technical and sub-technical vocabulary during their first weeks of attending sessions in their medical faculty at the end of their initial semester with the intention of exploring the degree of receptive recognition awareness that occurs during this period.

3. ***To what extent do medical students use the technical and sub-technical vocabulary productively in their academic writing?***

The third research question looks at the kind of productive vocabulary that medical students are capable of using in when writing their faculty essays. The degree usage of technical and sub-technical vocabulary included in it will be looked and discussed together with findings on the relationship between receptive and productive performance.

4. ***To what extent is L1 and L2 medical students' performance different in terms of receptive and productive technical and sub-technical vocabulary during their first semester of studies?***

The fourth research question looks at the effect of English as a first language (L1) or second/foreign language (L2) on the subjects' capacity to recognise and produce technical and sub-technical vocabulary.

The main contribution of the present study is to shed light on the L1 and L2 medical students' receptive and productive capacity for technical and sub-technical vocabulary of medicine. Thus, it provides a point of reference for the extent of technical and sub-technical vocabulary that medical students encounter through LETERs and the ability to recognise and produce it in writing. It is hoped that the insights gained from answering the research questions outlined in this section would enhance awareness of medical receptive and productive vocabulary, which can be a contributing factor to successful academic studies completion (Heidari, 2019).

1.5 Overview of the thesis

Chapter 2 aims to discuss key concepts related to the theoretical framework of the present thesis and review the current types of related research conducted in the field. Specifically, sections 2.1-2.3 review the concept of word knowledge in line with the purposes of the present study, which are specific to the study of Learning and Teaching Resources (LETERs). The following sections 2.4-2.5 discuss the key concepts of receptive vocabulary, recognition, and the mental lexicon. Then, the concept of productive vocabulary is discussed in sections 2.6-2.6.2 and the relationship between receptive and productive vocabulary is explored in the review of related studies in section 2.6.3, which the present study builds on. Furthermore, sections 2.7- 2.7.3 discuss the concept of technical vocabulary with related topics such as etymological features and a review of research on technical vocabulary in the area of English for Medical Purposes (EMP). Moreover, the sub-technical vocabulary is discussed in sections 2.8-2.8.1, which provide a definition and a review of the types of studies conducted in the area of sub-technical vocabulary in EMP. In addition, sections 2.9-2.9.5 discuss issues related to the design and process of corpora in light of previous research approaches on *identifying technical and sub-technical vocabulary in written texts, word count, frequency, range, coverage, corpus comparison and lexical density.*

The third chapter of the present thesis aims to discuss the methodological steps followed in order to answer the four research questions that this thesis is concentrated upon. At the time of the present study, standardised tests for examining both technical and sub-technical vocabulary receptive and productive knowledge in EMP for first year medical students were not available. In order to respond to this lack of availability, a number of ways were considered aiming to generate a methodological tool that assesses receptive recognition. Furthermore, the productive usage of technical and sub-technical vocabulary of first year medical students is discussed. Specifically, sections 3.2-3.4.5 describe the methodology that was followed for the generation of the Medical Receptive vocabulary Corpus (MEDREC), which is based on two sub-corpora: the Textbooks Sub-corpus and Online Resources Sub-corpus. The following sections 3.5-3.5.1 discuss the process of analysis of lexical density of the MEDREC in order to answer the first research question. Then, sections 3.6-3.6.8 discuss the processing of MEDREC data for the generation of the Receptive Recognition Task (RecRec), which is a user-friendly, innovative and effective instrument designed as part of this study for conducting vocabulary research in the field of EMP. Furthermore, sections 3.7-3.10 discuss the processes of administration of the RecRec tasks, ethical considerations, data entry and analysis with a view to provide answers to the second research question. Aiming to answer the third research question, sections 3.11-3.11.7 discuss the design, conduct, entry and analysis of the productive tasks, which formed the Medical Productive (MEDPRO) corpus. Finally, the methodology that was followed for the fourth research question is discussed in section 3.12.

Chapter 4 presents the findings of the present study from the LETERs density analysis, RecRec Tasks, Vocabulary Profiles (VP) findings, L1 and L2 performance on receptive and productive vocabulary (technical and sub-technical). Chapter 5 is the discussion chapter of the present thesis and the research questions are discussed directly. Lastly, Chapter 6 provides an overview of the present thesis along with its limitations, contribution, significance, implications and suggestions for future research.

Chapter 2 Literature Review

2.1 Introduction

The present study aims to contribute to advancing knowledge in the area of English for Medical Purposes (EMP), which belongs to the broader field of English for Specific Purposes (ESP) (Ruslanovna, 2017). This EMP study looks into two types of medical vocabulary on the basis that it is necessary to establish effective communication between members of the medical discipline (Ferguson, 2013). As this vocabulary has been used for centuries for this purpose, its scholarship was adopted in a number of languages such as Egyptian, Greek, Hebrew, Arabic, Latin, French, German and Chinese in Asian territories (Benfield and Howard, 2000). Its evolution and linguistic borrows from these languages, led to its idiosyncratic features today (see Table 1). Since the end of WWII, English has been used globally to share medical knowledge and, still, it has been claimed that it is the current lingua Franca of medicine (Ripamonti, 2015; Iturralde, 2018; Wermuth and Verplaetse, 2018). Thus, as Taylor (2017) described "The language of medicine is more or less English, but it is a very specialised subset of English, a sort of scholarly jargon. There are classical allusions, metaphors, similes, eponyms, acronyms, authorisms, and honorisms." (2017: 1). In addition, medical language is rich not only in terms of its variety of specific anatomical and functional concepts but it can also effectively describe nuances with references to people, places and events that each medical word item is attributed to.

The scope of this chapter is to review the literature that underpins the aims of the present thesis. Firstly, it outlines the concepts related to knowledge of a word, on both receptive and productive level. Secondly, it provides an overview of what is technical and sub-technical vocabulary in medicine with related studies.

First of all, word or vocabulary knowledge is a complicated notion to describe in simple terms owing to the fact that it involves multiple aspects and stages (Nagy and Scott, 2000; Beck et al., 2013). A number of researchers tried to solidify what it entails with an early classification conceptualised by Faerch et al. (1984), who suggested that every individual knows a number of words at varying degrees and types. Examples of which are: the potential (unknown) vocabulary, the receptive *vocabulary (for reading or listening) and the productive vocabulary (for writing or speaking). In addition, Meara (1996) highlighted two dimensions that need to be considered for lexical knowledge: a) how large ones' vocabulary is (vocabulary size) and b) how words are interlinked with each other in terms of concept relations in the mental lexicon (see section 2.5.2). To this day, a number of researchers attempted to classify what knowing a word entails, thus, a selective representation of vocabulary knowledge models is discussed in Table 2.*

As can be seen in Table 2, Dale (1965) approached vocabulary knowledge in the form of three stages starting from lack or no knowledge of vocabulary to sufficient knowledge of it. Dale (1965) effectively suggested that there are different steps to vocabulary knowledge; however, the proposed vocabulary knowledge model is not as detailed as Beck et al. (1987) were. Specifically, Beck et al. (1987) proposed four stages to knowing a word with a more elaborated but essentially similar model to Dale (1965). One aspect to vocabulary knowledge that is present in Beck et al.'s (1987) model but not in Dale's (1965) is phased (see Table 2), which relates to automaticity and fluency in vocabulary production (point d). Moreover, Laufer (1997) suggested a more detailed model of word knowledge than the previous two researchers did. Specifically, six types of knowledge were found to be involved in knowing a word (see Table 2). Successful word knowledge entails familiarity with all features, however, the process of knowing a word is incremental and consists of multiple stages such as awareness of certain meanings and lack of awareness of others, receptive awareness and productive awareness (Laufer, 1997). Further, Henriksen (1999) revised Laufer's (1997) model and proposed a more concrete classification of vocabulary knowledge by means of a systemic 3 tier model, as illustrated in Table 2. Specifically, Henriksen (1999) proposed size, depth and receptive and productive knowledge as key to vocabulary knowledge. Further, Nation (2001; 2013) classified word knowledge in three broad categories; form, meaning and use, with three aspects each (see Table 2).

Furthermore, Laufer and Goldstein (2004) proposed a more detailed model as regards to receptive and productive vocabulary knowledge based on four different levels of modality. This model takes into consideration the type of context a learner is in, which could affect vocabulary knowledge. For instance, in the context of the present study, passive recall was the skill involved in receptive *recognition investigated in the present thesis, which according to Laufer and Goldstein (2004), it has been linked with higher scores in overall language skills development (see section 2.5.1). Finally, a more recent view to vocabulary knowledge from Perfetti (2007) looked at it from six viewpoints, as detailed on Table 2. Specifically, it was claimed that the degree of one's knowledge of these aspects in any given word can specify a higher or a lower level of vocabulary knowledge in the mental lexicon (for further discussion on the mental lexicon, see section 2.5.2).*

It becomes clear that word knowledge is a complex phenomenon that has not received a concrete interpretation. Milton and Fitzpatrick (2014) described knowing a word as "an elusive concept and we are still unable to capture, in a simple description, everything that knowing a word might involve" (2014:1). From a pedagogical standpoint, the concept of word knowledge has been described as the ability to know and be aware of its multiple perspectives. Importantly, the topic of vocabulary knowledge in the discussion of this section is not exhaustive. This is because vocabulary knowledge is key to other parts of the present study, such as sections 2.8 and 2.9, where aspects of vocabulary knowledge are discussed.

In addition, receptive vocabulary knowledge of written texts involves awareness of word form (spelling) as a basic skill. Nation (2020) suggested that word knowledge of a lexical item with a set spelling involves awareness of its basic concepts and added senses except of homographs. In the case of homographs, the spelt form can be considered accidental (Bogaards, 2001). Spelling and core concepts are acquired earlier than other types of vocabulary knowledge such as genre and collocational patterns (Schmitt, 1998; 2000). Furthermore, acquiring the orthographical (spelt) form of words marks the beginning of receptive word recognition as well as the beginning of productive vocabulary writing (Ryan, 1997). Thereby, awareness of the spelling features of a word in written form is a foundation skill and it is one of the first to acquire. Thus, learners' vocabulary knowledge or lack of it is evident when they recognize or fail to recognize the spelling of lexical items they read.

Table 2. Summative Table of Featured Models of Vocabulary Knowledge.

Summative Table of Featured Word Knowledge Models						
Dale (1965) in Beck *et al.* (2013:p.4)	**Beck, McKeown and Omanson (1987)**	**Laufer (1997) p: 141**	**Henriksen (1999)**	**Nation (2001; 2013)**	**Laufer and Goldstein (2004)**	**Perfetti, 2007**
Stage 1: never saw it before **Stage 2: heard it, but do not know what it means.** **Stage 3: recognizes it in context as having something to do with_______.** **Stage 4: knows it well.**	a no knowledge b general sense; for example *mendacious* has a negative connotation c narrow, context-bound knowledge. d has knowledge of a word but not able to recall it readily enough to use it in an appropriate situation. e rich, decontextualized knowledge of a word's meaning, its relationship to other words and its' extension to metaphorical uses	[a] "Form-spoken and written that is pronunciation and spelling. [b] Word structure -the basic free morpheme (or bound root morpheme) and the common derivations of the word and its inflections. [c] Syntactic pattern of the word in a phrase and sentence. [d] Meaning: referential (including multiplicity of meaning and metaphorical extensions of meaning), [e] affective (the connotation of the word), [f] pragmatic (the suitability of the word in a particular situation). [g] Lexical relations of the word with other words such as synonymy, antonymy, hyponymy. [h] Common collocations."	Tier 1: fractional to specific awareness of a word, which is linked to vocabulary size Tier 2. deep awareness of a word, which is related to vocabulary depth Tier 3. receptive and productive awareness of the word, which refers to the relation of receptive awareness and productive ability of lexical items	Category 1: form (spelling, pronunciation and morphology) Category 2: meaning (labelling, reference and association) Category 3: use (grammar and collocation structures, register and genre awareness).	Level 1: passive recognition-easiest: (recognition with options provided) Level 2: active recall (identifying a word in a text when previously given its meaning) Level 3: passive recall (providing the meaning of a word when seen or heard) Level 4: active recall-advanced (producing a word in speaking or in writing)	a) meaning b) orthographic (spelling) c) semantic (word meaning), d) phonological (pronunciation) e) morphological and f) syntactic

As learners move beyond the recognition of word form to more sophisticated vocabulary knowledge, such as the acquisition of meaning, word knowledge becomes more complicated especially in cases of polysemy (see section 2.5). According to Krashen and Terrell (1983) and Aviad-Levitzky et al. (2019), in order to establish effective communication, word meaning is considered key. In addition, word knowledge was claimed to be superior to other types of word competence such as grammatical and syntactical knowledge on the basis that knowledge of words can lead to more effective communication than knowledge of grammar or syntax (Krashen and Terrell, 1983; Aviad-Levitzky et al., 2019). Other aspects that add to the complexity of word knowledge relate:

> *"multidimensionality—word knowledge consists of several qualitatively different types of knowledge; [...] polysemy—words often have multiple meanings; [...] interrelatedness—one's knowledge of any given word is not independent of one's knowledge of other words; and [...] heterogeneity—what it means to know a word differs substantially depending on the kind of word" (Nagy and Scott, 2000: p. 459).*

Interestingly, vocabulary knowledge happens in increments (Laufer, 1997; Nagy and Scott, 2000). Early research into vocabulary by Dale (1965) attempted to describe these incremental stages of word knowledge (see Table 2). Specifically, he described knowing a word item as "a continuum" (1965:898).

While word knowledge is not the only important element in linguistic acquisition, the approaches aimed to provide a general overview of the way word knowledge has been looked at and associated with so far. One of the advantages of vocabulary knowledge is the fact that it can be a contributing factor in four key language skills involving both receptive and productive skills, namely, reading and listening, writing and speaking (Coxhead et al., 2019). As far as reading development is concerned, Anderson and Freebody (1981) stated that knowing what a word means (word knowledge) is often an indicator of one's degree of comprehension of written texts. Specifically, Anderson and Freebody (1981) correctly point out: "It is also clear that word knowledge is a requisite for reading comprehension: people who do not know the meanings of very many words are most probably poor readers" (Anderson and Freebody, 1981:110). It appears from Anderson and Freebody's (1981) study that previous knowledge of a word is *a variable. Thereby, it contributes to effective reading capacity and awareness of the lexical meaning of a vocabulary item can be responsible for the overall understanding of a text. Based on the above, it can be understood that the vocabulary learners recognise receptively results in better readers. In addition, vocabulary knowledge is necessary in order to acquire the needed communicative competence in order to communicate verbally or in written mode (Heidari, 2019).*

Furthermore, Beck et al. (2013) suggested that knowledge of vocabulary can be classified into three categories: a) the highly frequent vocabulary; for instance words such as eat, drink, play, b) words used across many disciplines such as obesity, swelling and clot and c) scientific and rare vocabulary such as cyclosporine, codeine and hypoxia. In addition, Beck et al. (2013) further added that the disciplinary and infrequent vocabulary appears more frequently in written rather than spoken English. This type of vocabulary is aimed at in the present study, specifically, the examination of the written form of medical vocabulary. In the medical context, acquiring the vocabulary of the discipline adheres to the principles of vocabulary knowledge discussed above.

Furthermore, the medical vocabulary tends to acquire special meanings, to illustrate, the word: evacuator may have a different meaning for a health specialist and a different meaning for a mechanical engineer. Apart from this, language and word meanings are evolutionary as words and terms have the propensity to change over time making it challenging to assess their meaning accurately. Given that medicine is a living science with new diseases and treatments developed incessantly, it constantly evolves. Thus, new terms are generated to refer to novel concepts, often with a lack of consistency between the two (Wermuth and Verplaetse, 2018). This means that some word meanings are not related to their referring concepts and they are often subject to change in line with recent trends in science development.

Thus far, this section discussed vocabulary knowledge approached from different dimensions, which are indicative of the complexity it entails. On average, a typical educated L1 individual possesses approximately 17,000 words in his/her mental lexicon by acquiring an approximate amount of 1-3 new words per day (Goulden et al., 1990). In the case of L2 subjects, 8,000 to 9,000 word families are necessary in order to reach 98% of lexical coverage (Nation, 2006) for the comprehension of written texts. In this section, a number of vocabulary *knowledge dimensions is discussed in order to provide the theoretical framework that lexical knowledge entails. Although the discussion is not exhaustive, it is evident that the essence of vocabulary knowledge involves a number of aspects. It can be suggested that a broad distinction of vocabulary knowledge is the receptive and productive. This view goes in line with the Common European Framework of Reference, CEFR (Council of Europe, 2018), which documented two key types of vocabulary knowledge, namely, the receptive and productive knowledge. Nation (2020), who defined word knowledge based on these two broad categories, further supported this view. According to Nation (2020),*

> *"Receptive knowledge is the kind of knowledge needed for listening and reading. At its most basic, it involves being able to recall a meaning when meeting a word form. Productive knowledge is the kind of knowledge needed for speaking and writing. At its most basic it involves being able to recall a word form in order to express a meaning." (2020:16).*

This definition of receptive vocabulary knowledge is the most up-to-date and it reflects a significant number of the features presented in Table 3. It is uncomplicated, practical and in line with the purposes of the present study.

2.1.1 Intentional and Incidental Vocabulary Learning

Intentional learning relates to learning vocabulary directly from explicit instruction while incidental relates to learning indirectly by encountering various examples of target words and use them by focusing on the intended message rather than the word itself (Paribakht and Wesche, 1996). According to Webb and Nation (2017) incidental learning is usually a desirable outcome when performing a receptive task such as reading or listening, where learners have the opportunity to encounter vocabulary used in context. In that case, a fine attunement between the text input and learners' current level of linguistic competence is necessary for incidental learning to occur (Krashen and Terrell, 1983). In addition to this, Webb and Nation (2017) added that incidental learning is reinforced when learners are introduced to the target vocabulary as many times as possible. The principles of incidental and intentional learning can be applied especially when learners are offered opportunities to encounter both types of learning. This is because according to Nation (2020) "Vocabulary *knowledge is most likely to develop if there is a balance of incidental and appropriate deliberate opportunities for learning" (2020:15). Similarly, Webb and Nation (2017) suggested that in order to help learners acquire disciplinary vocabulary it is ideal to combine the advantages of both intentional and incidental learning.*

In practice, activities that facilitate incidental and intentional learning should be designed and offered to learners. Incidental learning occurs when learners who are exposed to language stimuli are required to focus on meaning rather than on the unknown vocabulary (Wesche and Paribakht, 1999). On the other hand, intentional learning can occur through set activities that require students to involve with in finding an answer. Dang (2020) claimed that deliberate learning may be suitable for acquiring a significant number of disciplinary vocabulary. Although deliberate or intentional learning is ideal in disciplinary vocabulary learning, it is not always possible for a number of reasons. First, lectures are limited (Webb and Nation, 2017) and not all language instructors are experts in disciplinary fields (Coxhead, 2018). In addition, the necessity for word consolidation and learning needs multiple encounters (Webb and Nation, 2017), which often occur outside the class (Schmitt, 2008). For these reasons, it can be suggested that incidental learning is a more likely option in academic settings, which encourage independent learning and coursework.

Incidental learning typically occurs as a result of a previous activity involving receptive skills, such as reading (Gass et al., 2013). This is because when learners read or listen to information related to a task, they inadvertently encounter a number of word items, which can lead to incidental learning if encountered repeatedly. Repetition is key to incidental learning; as incidental learning happens in increments and with each repetition, new increments are added into the mental lexicon (Webb and Nation, 2017). Reading texts was claimed to be supporting vocabulary growth by means of offering repeated exposure to learners in authentic discourse (Pellicer-Sánchez and Schmitt, 2010). Specifically, Rott (1999) suggested that 2 to 4 encounters with a new vocabulary item were sufficient for a new word to be added in the mental lexicon and 6 encounters could strengthen receptive knowledge and memory for future use (see section 2.2.1). On the other hand, Pigada and Schmitt's (2006) study suggested that word form can be acquired from a single encounter. However, in order to build not only on word *recognition of spelling but also on other properties such as meaning and grammar, words should be encountered between 6 to 10 times. In a study by Pellicer-Sánchez and Schmitt (2010), 10 exposures of a new item in an authentic material were considered as a minimal amount of exposures for a word to be added to receptive vocabulary. In order for receptive vocabulary to be used productively, 28 and above encounters were claimed to be the benchmark. More recently, Dang (2020) suggested that the more exposures to a word item the more likely to acquire it incidentally. Specifically, the researcher suggested that a total of twenty (n. = 20) exposures to a word item are ideal for incidental vocabulary to bear significant results. Thereby, the more frequently learners encounter lexical items, the higher the possibilities to recognize their written form. Thus, when vocabulary is frequently recycled, it creates the ideal condition for incidental vocabulary to occur (for further discussion on word frequency, see section 2.9.2).*

An interesting study in the area of incidental vocabulary was conducted by Rott (1999), who looked into the impact of reading activity on incidental vocabulary learning and subjects' capacity to retain it. The researcher followed a group of English L1 learners of German as an L2, and introduced vocabulary that was not known to participants at the time of the research. She concluded that two to four exposures of new vocabulary items were enough in order to add them in the mental lexicon and six times exposure could enhance vocabulary building and ability to retain it. This goes in line with Nation (2001) who maintained that the more times one encounters with lexical items in a language, the more his/her familiarity with new vocabulary would develop. In addition, Paribakht and Wesche (1997) conducted two experiments with different subjects and the same vocabulary items. The first group of participants had a reading task followed by questions aiming to assess understanding. The second group of participants was given a reading task followed by vocabulary exercises. Findings from their study suggested that although both groups of students' incidental vocabulary had increased significantly, the greatest potential for higher levels of vocabulary recognition and productive use lies on the first group of students who were assigned comprehension tasks.

The incidental vocabulary learning is a well-recognized theory of learning vocabulary in linguistics research and it became the basis for the development of *suggestive specialised wordlists in ESP and particularly in the EMP research. As discussed in this section, this is because frequent exposure to word items can result in new additions in the mental lexicon since receiving instruction by focusing on frequently occurring lexical items is considered as an effective and practical way to prepare students for the vocabulary they would encounter in their scientific fields. In this way, in the case of disciplinary vocabulary, wordlists can make it possible for students to acquire the specialized vocabulary that is used frequently in their discipline (Dang, Coxhead and Webb, 2017). In addition, the more frequently unknown words are introduced to learners, the more opportunities to generate stronger mental associations of the new word and eventually learn it (Nagy et al., 1985; Carver and Leibert, 1995; Hulstijn et al., 1996). According to Nation et al. (2016), through wordlists teachers and learners focus on particular vocabulary increasing the chances of students' repetitive exposure. In addition, they claimed that exposure to vocabulary in receptive or productive tasks can instigate incidental learning and increase effortless understanding and use of the vocabulary that specialised wordlists target. In addition, due to the clearer relationship between the target vocabularies in the wordlists of specific disciplines, specialized wordlists can be motivating not only for instructors but also for learners (Coxhead and Hirsh, 2007).*

The distinction between incidental and intentional learning is not black and white especially when learning of the vocabulary that expresses subject knowledge. Additionally, the use of contextual cues is important in this discussion as they affect learning vocabulary related to subject knowledge. By using contextual cues, learners can be in the position to decipher the meaning of a word in a text without necessarily needing to activate their intentional or incidental learning. Thus, incidental vocabulary can be an effective way to introduce learners to new vocabulary items. In the context of the present study, word recognition and productive usage might be affected by incidental learning opportunities offered by using the Learning and Teaching Resources (LETERs), which is one of the most influential sources where medical students acquire the written form of words.

2.2 Learning Vocabulary from Learning and Teaching Materials (LETERs)

Following the discussion on incidental vocabulary in section 2.2.1, it can be suggested that studying from materials such as the LETERs has the potential to facilitate incidental learning. Multiple encounters enhance familiarization with the receptive word recognition of form, which is the first and easiest type of lexical knowledge when encountering a new word (Laufer and Rozovski-Roitblat, 2015). The role of LETERs in advancing receptive knowledge and, specifically, incidental receptive recognition of word form is meaningful. This is because by reading texts such as the LETERs, it may be possible to learn and expand on vocabulary knowledge and the form/spelling of words (Krashen, 1989; Ryan, 1997; Nation, 2001; Szubko-Sitarek, 2015). An explanation for this was provided by Pigada and Schmitt (2006) who asserted that the more often learners encounter word items in reading materials, the more advanced the knowledge of word form (spelling), as well as other features such as meaning and grammar can be. Evidence from their study led them to suggest, "spelling is a type of word knowledge that is especially amenable to exposure to comprehensible input" (2006:21). These suggestions are meaningful because they advocate that reading materials can be sources of a large amount of vocabulary input, which can lead to development of overall reading skills (Nation, 2001; Read, 2000). McQuillan (2019) moved on to compare direct teaching with incidental learning concluding, "reading is more efficient in acquiring new academic words than direct instruction" (McQuillan, 2019, p: 134). It appears, thus far, that reading materials can have the potential to introduce students to word forms effectively and this proposition may be pertinent to LETERs in the present study.

In this study, LETERs were the main reading resources and their efficiency depend upon three key factors that have been identified in the literature. The first factor relates to presenting learners with materials that interest them. For instance, Cho and Krashen (1994) suggested that presenting readers with materials that are of interest to them could have a meaningful impact on the amount of vocabulary they acquire. In addition to this, reading can help learners increase their vocabulary gains and the more familiarized they become with target vocabulary the more potential they have to increase their vocabulary gains (Webb and Chang, 2015). A suggestion from Krashen (1989) was that in order to create a *natural habitat for learning and expanding on vocabulary it is important to offer opportunities and materials for learners to read. In the context of the present study, a large amount of vocabulary was presented to learners who studied the LETERs individually and was recycled when LETERs were used during lectures, tutorials and practicals.*

The second factor relates to the use of original and authentic reading materials, which can have a positive impact on receptive vocabulary gains. This is because authentic texts usually present the intended vocabulary in context, which, according to Nagy et al. (1985), it is a contributing factor in the incidental learning of vocabulary through reading. Specifically, Pellicer-Sánchez and Schmitt (2010), who investigated authentic text materials in a group of L2 participants, claimed that repeated exposure to authentic texts aids vocabulary expansion. Subjects were presented in authentic English reading texts including lexical items from the Nigerian language of Egbo, unknown to participants. Researchers found that participating students acquired many of the properties of Egbo vocabulary by encountering them in reading texts. In a similar way, it is anticipated that in the context of the present study medical students would acquire some properties of words such as form or usage by means of encountering them in authentic materials of the LETERs (see sections 3.3 and 3.4). In this case, it is appropriate to consider that in the context where the present study took place, LETERs were authentic resources, and they were not modified for the purposes of the present study.

The third factor is associated with the suitability of texts according to learners' level. This is because limited knowledge of vocabulary in texts suggests difficulty in reading (Stahl, 2003). On the other hand, when reading materials are selected based on learners' current level of competence, learning can be maximized and can have a positive influence in vocabulary acquisition (Cho and Krashen, 1994). Similarly, Nation (2013) suggested that texts that are selected based on learners' current vocabulary level could be particularly helpful and lead to effective incidental learning of vocabulary items. In the context of the present study, it is uncertain to what extent LETERs correspond to individual learners' vocabulary level of competence, however, they were streamlined based on topics that were part of their curriculum learning goals. It is anticipated that if texts satisfy the three factors discussed in this section, incidental learning would occur in *receptive or productive level. This goes in line with Gablasova (2014b) who suggested that the learning of disciplinary vocabulary from studying is associated with incidental learning. However, it is important to consider that findings from these studies reported in this section typically involved L2 learners of General English. Taken that there is a lack of research studies involving medical students vocabulary acquisition from LETERS, it can be tentatively suggested that the LETERs that medical students utilize in order to learn scientific facts, concepts and processes may have a positive impact on their vocabulary development.*

2.3 Vocabulary Learning Burden

According to Nation (2013), learning burden is a concept associated with the degree of mental energy that learners need to exert in order to learn vocabulary successfully. Specifically, knowledge of a word entails knowledge of a number of different aspects, as discussed in section 2.2 and each aspect of vocabulary knowledge carries its own learning burden with it. When learners have a pre-existing familiarity with a word's aspects, then the learning burden is going to be lighter compared to when there is no pre-existing knowledge (Nation, 2013). In this way, learners who intend to learn new vocabulary may find it easier to learn it if it has elements such as a similar word form, affix or grammar that is related to their already learnt language(s) (Nation, 2013). Nation (2013) related this theory with learning two different languages. Specifically, he claimed that when a subject tries to learn a new language that shares many similar features with their new language, it is highly likely that the learning burden would be lighter compared to learning a new language that does not share similar features, in which case the learning burden would be a lot heavier.

In a similar way, when mastering the vocabulary of medicine, Nation's learning burden theory can explain potential areas of difficulty or excellence in technical or sub-technical vocabulary. By taking the proposition that pre-existing knowledge of vocabulary can significantly reduce learning burden, it can be suggested that previous awareness of vocabulary items may make it easier to acquire target vocabulary. Considering the learning burden theory in the medical context, it can be suggested that medical students with pre-existing familiarity with medical terms or word parts that constitute technical or sub-technical vocabulary may have a lighter learning burden compared to the ones who do not.

At the same time, according to the learning burden theory, subjects who study medicine or EMP may find the technical or sub-technical vocabulary easier if they had previous knowledge of a language that contributes towards medical English, as discussed in section 2.6. When medical students possess knowledge of key words or word parts that are used in medical vocabulary, this can contribute towards minimizing learning burden.

2.4 Receptive Vocabulary

One aspect of vocabulary knowledge that was discussed in section 2.2 relates to receptive or passive vocabulary. This type of knowledge is discussed in this section in an effort to add to the theoretical framework outlined in this chapter. Nation (2001) defined the term receptive vocabulary as the "perceiving of the form of a word while listening or reading and retrieving its meaning" (2001:24-25); thereby, it is suggested that receptive knowledge involves both listening and reading skills. However, it was found that only 39% of the receptive vocabulary from listening and 72% from reading correlated with vocabulary size (Staehr, 2008), thus, highlighting the role of receptive vocabulary in receptive skills. For receptive knowledge to operate, two skills are key: the receptive recognition as well as understanding of meaning of vocabulary items (Nation, 2001). Since the present study is not specifically looking into the meaning aspect nor into the listening skills, as proposed by Nation (2001) receptive vocabulary will be considered from the perspective of the type of vocabulary that readers encounter in written form.

One feature of receptive vocabulary relates to its propensity to be larger than the productive vocabulary. One reason for this is the fact that receptive vocabulary is activated prior to productive vocabulary (Webb, 2008; Carter and McCarthy, 2014). In addition, learners of a language need to reach a certain level of receptive comprehension of a word prior to producing it verbally or in written mode. The process of achieving knowledge of receptive knowledge is claimed to be less demanding compared to productive knowledge (Nation, 2020). In addition, Nation (2020) extended his original definition of receptive vocabulary by proposing three key aspects to knowing a word receptively and productively, namely: form, meaning and use. Specifically, meaning and use associate with the quality of receptive word knowledge (vocabulary depth) that learners possess in *areas of language use and it involves knowledge of various meanings, derivations and associations of a word item (Anderson and Freebody, 1981; Webb, 2020). Another view to vocabulary knowledge refers to the amount of lexical items that individuals possesses in the mental lexicon, i.e. "vocabulary size" or "breadth of knowledge" (Anderson and Freebody, 1981:93). According to this view, it is expected that individuals may steadily increase their vocabulary size as they grow (Miller, 1978; Anderson and Freebody, 1981:93).*

Table 3. What is involved in knowing a word. Adapted from Nation, I., S., P. (2020) The different aspects of vocabulary knowledge. In Webb, S. (Eds.) The Routledge Handbook of Vocabulary Studies. Oxon and New York: Routledge, pp: 16.

What is Involved in Knowing a Word (Adapted from Nation, 2020)			
		Receptive	**Productive**
Form	**Spoken**	What does the word sound like?	How is the word pronounced
	Written	What does the word look like?	How is the word written and spelled?
	Word Parts	What parts are recognizable in this word?	What word parts are needed to express the meaning?
Meaning	**Form and Meaning**	What does this word signal?	What word form can be used to express this meaning?
	Concepts &Referents	What is included in this concept?	What items can the concept refer to?
	Associations	What other words does this make people think of?	What other words could people use instead of this one?
Use	**Grammatical Functions**	In what pattern does the word occur?	In what patterns must people use this word?
	Collocations	What words or types of words occur with this one?	What words or types of words must people use with this one?
	Constraints on use (register, frequency)	Where, when, and how often would people expect to meet this word?	Where, when, and how often can people use this word?

When examining vocabulary size, learners' awareness of word spelling is key (Webb, 2020). In addition, Nations' (2020) classification of word form in relation to vocabulary knowledge is related to size or breadth and is indicative of how wide ones' lexicon is, which is one of the points examined in the present thesis.

As Table 3 demonstrates, receptive and productive awareness of word form relates to three types of knowledge, namely, spoken form, written form as well as word parts. It should be mentioned here that all three aspects to knowing a word form are important during the process of language learning. For the purposes of the present study the focus will be on one of the first aspects of gaining receptive vocabulary knowledge from reading texts, which is the orthographic ("being familiar with its' written form so that it's recognised when it is met in reading" (Nation, 2001:27-28). This is because the orthography (spelling) of a word is the first aspect to familiarize when encountering words for the first time in written form. It relates to recognizing what a word looks like and how a word is spelled when used productively in written texts. As this study aims to focus on medical students and evaluate the degree of receptive vocabulary growth over a period of time in terms of its basic aspects to knowing it, the orthography of receptive vocabulary, which is considered as its' first aspects to familiarize with new vocabulary in written form will be the main focus of the present study.

2.4.1 Receptive Recognition

Receptive word recognition of written vocabulary is a rapid process that occurs every time individuals encounter word items in written form. The process of word recognition seems to be unique for every individual as the extent of recognition of the characteristics of each lexical item vary (Aviad-Levitzky et al., 2019). Differences in the degree of word recognition are often related to the degree of practice and training subjects receive in their learning environment (Daniele, 2015). In addition, it is one of the first mental processes when encountering vocabulary items. Interestingly, it happens incredibly fast; according to Marslen-Wilson (1989), it takes 200ms for receptive vocabulary recognition to occur, which suggests that an individual who is reading or listening to a word item may have finished recognizing it before finishing reading/repeating it aloud. The process of word recognition of a written word item is further elaborated by Szubko-Sitarek (2015) on both receptive and productive level:

> *“[vocabulary recognition] involves receiving a perceptual signal, rendering it into the [...] orthographical representation and then accessing its’ meaning. The opposite process of producing a word requires first choosing a meaning for the intended concept, then recovering its’ phonological or orthographic representation, and finally converting it into a series of motor actions” (2015:52).*

Miralpeix and Meara (2014) who proposed, “written word recognition [...] is the ability of a reader to recognize words correctly and effortlessly” (2014:30) provided an effective definition of visual word recognition of vocabulary. In addition, Harrington (2018) associated word recognition with “the ability to recognize the association between a single word form and a basic meaning” (Harrington, 2018:21). It seems that recognition of word form is associated with multiple perspectives such as recognition of its’ spelling (orthography), pronunciation and meaning. Orthography, in particular, was considered as one component that is indicative of effective reading ability, yet it does not provide clear information with regard to understanding the meaning of a text (Katzir et al., 2006).

Receptive word recognition is a multidimensional concept in vocabulary studies and it relates to receptive vocabulary awareness of features such as orthography, phonology and meaning. Receptive recognition is “an important step in the development of lexical knowledge” (Stoeckel, McLean and Nation, 2020:pp.3). Once learners master the initial step to vocabulary knowledge, which is the recognition of form, it is impossible to remain static in their development because awareness of the form of a word is not sufficient to learn a language (Stoeckel et al., 2020). According to Nation (2020), receptive recognition of word form is associated with receptive skills such as reading and listening and it was suggested that word recognition of form occurs prior to attributing meanings in each vocabulary item (Laufer, 1997; Moghadam et al., 2012). Once awareness of form is achieved, learners begin attributing meanings of various degrees to each word item. This goes in line with Laufer and Goldstein (2004), Laufer, and Rozovski-Roitblat (2015) who considered the knowledge of form as the first and least demanding type of knowledge one can obtain when learning new vocabulary in any language. In addition, it was advocated, “A person who can retrieve *the word form for a given concept is typically able to retrieve its meaning upon encountering the form." (Laufer and Goldstein, 2004: p. 408). In addition, Barcroft (2002) and Pellicer-Sánchez and Schmitt (2010) highlighted the significance of instructors focusing students' attention to written word form in order to introduce them to this basic feature prior to advancing other types of word knowledge such as word meaning.*

It seems that the process of recognizing vocabulary items in written form aims at identifying the form by gaining access to the mental lexicon. In order to understand the concept of vocabulary recognition better, it is important to mention three influential approaches of how vocabulary is stored inside the mental lexicon. A more elaborated discussion on receptive recognition and the involvement of the mental lexicon in this process will be provided in the following section 2.5.2.

2.4.2 Receptive Recognition and the Mental Lexicon

This section aims to discuss theories of access and storage of vocabulary in the mental lexicon and the underlying process involved in vocabulary recognition and productive usage. Although the mental lexicon is not directly assessed in this study, it takes part in the process of word recognition and usage indirectly; hence, it will be mentioned in this section in order to enhance our understanding of it.

The mental lexicon is an abstract concept and so far, no concrete definition has been given to it. According to Brysbaert et al. (2016), an adult speaker of a single language owns more than 11,000 words inside the mental lexicon. According to McCarthy (1990), the mental lexicon relates to the ways in which vocabulary is structured inside the brain. In essence, when subjects encounter new vocabulary items, they make a mental memo of its image features such as its letter combination or its syllables (McCarthy, 1990), size, number of known words, grouping and linking (Meara, 2006) and related information about the words (Szubko-Sitarek, 2015). As each word moves in to the avenues of the mental lexicon, the brain would endeavour to create associations and make meaning.

One theory of the mental lexicon in operation holds that it is a circuit system stored inside the brain. It works by assuming that every word item contains *points, or ends, that that fire information between word items and are stored separately in the brain (Meara, 2006). According to his word networking theory, the ends activate word knowledge when connected with two other ends. The more activations on the ends the better connected the words in the mental lexicon and the more chances for receptive recognition and production. In the case of enriching one's mental lexicon in more than one language, it was claimed that L1 and L2 vocabulary are stored into separate compartments with interlinks between word items (Cook, 2003; Meara, 2006; Singleton, 2007). To complement this theory, Meara (2006) suggested that inside the mental lexicon, vocabulary in an L2 interweaves with the L1 vocabulary without necessarily losing their special place inside the mental lexicon. This means that certain word items in a language would be stored on a separate part of the mental lexicon while they might mix with items from another language (e.g. L1, L2 or L3).*

As far as the storage of vocabulary in the mental lexicon is concerned, it received tree influential theories. The Full Listing Hypothesis or Whole Word Hypothesis (Marslen-Wilson et al., 1994; Giraudo and Grainger, 2000; Szbuko-Sitarek, 2015) suggests that vocabulary entries in the mental lexicon are similar to the entries of a dictionary with each word and its affixes listed separately (Butterworth, 1983; Henderson et al., 1994). An example of this could be the medical words fascia and fasciae, where fasciae is the genitive case of the medical term fascia and receives the suffix –e, which is typical of genitive case suffix in Latin. According to this theory, both words fascia and fasciae would be stored in two separate entries within the mental lexicon along with related information (Butterworth, 1983 and Henderson et al., 1994). According to the full listing hypothesis, during the receptive recognition and productive use of the two words fascia, fasciae, the mental lexicon should activate these vocabulary items separately (Vigliocco and Hartsuiker, 2005).

A contrasting theory to the Full Listing Hypothesis is the Decompositional Theory; according to this theory word items are considered as an assembly of morphemes. Taken that morphemes carry the core meaning in lexical items, it was suggested that the mental lexicon does not store lexical items in separate entries in the form of words, as the Full Listing Hypothesis proposes, but in the form of morphemes (Manelis and Tharp, 1977; Taft, 2004; Frost and Ziegler, 2007). In order for the mental lexicon to recognize a word item effectively, it is *necessary to decompose it into its morphemes and access them separately, while the reverse process takes place for productive usage. For instance, when encountering the word: hepatomegaly in a reading text or oral speech, medical students may break it down to its' morphemes: hepato (=liver) and megaly (=large) and make out the meaning of the word: enlarged liver.*

The third theory, the Hybrid Model, accepts both theories mentioned above; during the process of lexical recognition the Full Listing Hypothesis, which focuses on the meaning, and the functions of the Decompositional Theory, which focus on morphological analysis of the components of a lexical item, function in a parallel manner (Diependaele et al., 2009). This suggests that access to the mental lexicon when recognizing a word item can be achieved by both utilizing the lexical entries, as suggested by the Full Listing Hypothesis, and by breaking down word items into morphemes, as suggested by the Decompositional Theory. The Hybrid Model, therefore, was suggested as a more flexible alternative between the first two theories of access to mental lexicon when recognizing a word and aimed to overcome the shortcomings of the previous two theories. Some of the shortcomings of the Full Listing Hypothesis is that it utilizes excessive amounts of storage in the mental lexicon making it inefficient (Levelt, 1989; Frost and Ziegler, 2007; Taft, 2004). At the same time, the Decompositional Theory was considered as time consuming especially in cases of long and complex word items (Bozic et al., 2013), given that vocabulary recognition should not take long to occur (Szubko-Sitarek, 2015). In other words, the Hybrid model can be considered as a compromise between the two models of lexical recognition mentioned previously and can make it possible to complete numerous lexical recognition processes effectively (Diependaele et al., 2009). For instance, the medical word hepatitis can be recognised both as a whole meaningful word according to the Full Listing Hypothesis and as two meaningful morphemes <hepat-=liver>+<-itis=inflammation>, as suggested in the Decompositional Theory. Diependaele et al.'s (2009) experiments have shown that although the Decompositional Theory process takes place with novel vocabulary, it soon becomes replaced by the Full Listing Hypothesis as readers become more experienced. According to Ping (2018), the Hybrid Model is practical and flexible in that it considers a parallel processing of visual word recognition. In addition, Beyersmann et al. (2012) commented that the Hybrid model provides the opportunity to the readers to utilize two word analysis methods in order to make the most of their texts.

Theories on mental lexicon and its access and storage are popular in that they constitute efforts to understand the internal workings inside the brain. They were discussed in this section in order to gain an understanding as to how vocabulary is recognised and accessed for production purposes. It can be assumed that the Hybrid model is a more flexible framework under which visual recognition operates by combining features of both the full listing hypothesis and the morphological decomposition theory in order to maximise readers' efficiency when encountering with a word item. This is the line of thought that the present thesis follows in line with Booth (2021b) and Szubko-Sitarek (2015), who suggested that learners might use them alternatively. It should be mentioned here that although mental lexicon theories are interesting areas of scientific thought, they have not yet been verified with scientific evidence.

2.5 The Challenge of Medical Receptive Vocabulary

The vocabulary used in medicine aims to raise awareness of concepts and, therefore, it is specific for students, scientists and practitioners of medicine. According to Corson (1997) and Gass et al. (2013), there are numerous complicated vocabulary items present in English, which typically derive from Latin and Greek and acquisition is an essential step towards high achievements in education particularly within the academia. According to Salager (1985) nearly 75% of technical vocabulary is either deriving directly from Greek or Latin or is neologisms based on Greek or Latin themes (Salager, 1985), which goes in line with documented evidence from a medical dictionary analysis of lexical entries reported in Table 1. As Taylor (2017) correctly points out:

> *"Most of today's medical terms had their origins in ancient Greek or Latin or perhaps other languages such as Quechua (quinine), Malay/Indonesian (agar), and Singhalese (beriberi). In addition, some can be traced to very early times. Medical words may arise because of a sound, (as in "cough"), an appearance or shape (think of the trapezius muscle), a region (Caucasian), a mythological figure (from Hygeia, the daughter of Aesclepius, comes our word hygiene), or even a person's name (such as Hippocratic or Addisonian)" (2017: vii).*

It is evident from the above that medical vocabulary in English is complicated as foreign languages and myths may affect it. Specifically, technical vocabulary has been claimed to be one of the most difficult types of vocabulary reported by L1 Chinese university students (Evans and Morrison, 2011).

One of the reasons why medical vocabulary is challenging relates to the fact that a number of words from different languages are included in it and learners need to acquire them as part of their learning of the disciplinary vocabulary. Another reason relates to the attachment of specialised meanings that relate to the subject knowledge they represent, which is often complicated and precise. Therefore, it is considered that subjects' lack of awareness of specialized vocabulary is indicative of missing subject knowledge. Despite this, it was considered less challenging to acquire additional meanings of a word than learn a completely new word (Nation, 2020). When learning medical English, learners would typically encounter the Anglo-Saxon features present in English "the familiar homely-sounding and typically very short words [and] the more learned, foreign-sounding and characteristically rather long words" (Randolh Quirk, 1974:138), which are often of Graeco-Latin origin. In addition, learning the Graeco-Latin vocabulary as part of learning medical vocabulary could be looked at as a second language because it is lexically distant from everyday conversations in English (Maylath, 1997). This view goes in line with Coxhead (2018) who suggested that L1 subjects' degree of cognitive effort that is exerted while trying to write in highly specialized language was similar to students trying to learn how to write in a second or foreign language. In addition, one in every three words is technical in medical English, as suggested by Chung and Nation (2003) and verified by Quero (2015). Dang and Webb (2014) who claimed, "the lexical demands of academic speech from life and medical sciences are likely to be greater than those from other disciplines" (2014:439) further reinforced this finding. Given the demanding nature of medical vocabulary (Chung and Nation, 2003; Dang and Webb, 2014; Quero, 2015), it can be suggested that it may require more intense cognitive effort in order to be learnt and used effectively owing to the fact that words are often morphologically dense, thereby, limiting the possibility to process them with ease. In addition, these words happen to be of low frequency in English and not typically used in everyday conversations.

It should also be mentioned here that not all subjects recruited in the present study were given the chance to acquaint themselves with Greek or Latin, which form part of the root or affixes of technical and sub-technical vocabulary of medicine, prior to initiating their medical studies. This is further confirmed from statistical findings on the degree of participating subjects' awareness of classical languages in section 3.8.2. Thus, it could be the case that because the majority of L1 and L2 medical students did not seem to have encountered these words prior to entering the faculty, they may face similar challenges in learning and using them receptively and productively.

2.6 Productive Vocabulary

Productive vocabulary refers to the type of vocabulary that is used to speak or write in a language; it involves "being able to recall a word form in order to express a meaning" (Nation, 2020:16). Laufer and Paribakht (1998), who named productive vocabulary as active, offered another term for productive vocabulary. Thus, active or productive vocabulary is considered as the type of vocabulary used when individuals externalize what they think or feel (Webb, 2005). Productive vocabulary is a result of a combination of multiple kinds of knowledge and skills. Apart from the awareness of meaning, it involves knowledge of the spelling of a word, word formation, lexico-grammatical knowledge and word association knowledge such as synonyms or antonyms (Webb, 2005). In addition, productive vocabulary entails awareness of collocates such as collocational structures, where words can be used correctly, and awareness of the genre or disciplinary context where words are in use (Nation, 2013). This goes in line with Schmitt (2000) who suggested that productive knowledge of a word can be indicated by means of appropriate usage in context and, thus, should be considered as effective only in the context where it has been produced. In addition, Gass et al. (2013) maintained that productive vocabulary involves awareness of appropriate use of vocabulary according to context, which is a contributing factor to successful word production. By investigating the type of vocabulary used in productive tasks, it can be possible to observe the diversity of the vocabulary used in writing (Hamada, 2020).

Because knowing a word productively entails a combination of different kinds of word knowledge, Nation (2001) concluded that knowing a word receptively might *be easier compared to knowing it productively. Specifically, receptive knowledge can be first achieved by acquiring a word form (spelling or sound) while productive knowledge involves the aspects of "meaning, form, word class, collocation and association" (Zhong, 2018: 360) and they were all put to the test by Zhong (2018). Results indicated that word form and meaning were the strongest predictors of her participants' capacity to produce the lexical items tested. This finding suggests that awareness of form and meaning are often indicative of the degree of word production; thus, according to Zhong (2018), knowing how a word appears on a text (i.e. its orthography) as well as its meaning(s) can be predictors of the degree of productive usage in writing. It should be mentioned here that in order to be able to produce vocabulary in any shape or form it is necessary to have developed receptive vocabulary first. Thus, in this thesis productive vocabulary will often be discussed in relation to receptive vocabulary.*

2.6.1 Productive Vocabulary in the Academic Medical Context

Productive vocabulary is an essential skill that students need in order to cope with their university studies. This is because the ability to produce meaningful ideas in an appropriate context-specific way is highly valued in university contexts. For instance, in the field of health sciences, Itua et al. (2014) conducted a retrospective qualitative study regarding problems that contribute to low quality academic writing in the discipline. Data collected from 70-second year students in health sciences, 6 lecturers from the field of health sciences and three college instructors were utilized to study factors that contribute to the low quality of academic essay production. These were: the short time frame in which students were requested to complete their academic writing task, low self-esteem, lack of adequate preparation prior to the commencement of their studies, inaccessible language used in their learning resources and getting to know how to reference sources and the usage of disciplinary vocabulary. Regarding disciplinary vocabulary usage, it was interesting to mention the difference in perspectives between students and lecturers. More specifically, during the writing of the essay and prior to submission, it seemed that students' focus was on writing about the facts than on the use of language. On the other hand, it emerged from the data that lecturers in health sciences were encouraging and focusing on more subject-specific vocabulary and expression when marking the *academic essays submitted by their students. It is evident from the findings of this study that the use of appropriate vocabulary can be one of the main denominators for higher scores in academic writing for health sciences.*

Another study conducted at university context looked into productive writing in the form of essays from the perspective of the academic examiners such as university professors by Santos (1988). Out of the 178 university professors, 82 affiliated with the field of physical sciences and 96 with the field of humanities and social sciences. Professors were given two texts produced by one Korean and one Chinese student and asked to rate the content and language of the texts. Findings from this study suggest that, on average, language gained more marks than content. Further, Santos (1988) discussed the interrelationship between these two types of error:

> *"although they [professors] regarded [lexical] errors as linguistically unacceptable, the professors still judged content and language independently, to the extent that this was possible. However, this seems not to have been possible with the error type considered the most serious: the lexical error. It is precisely with this type of error that language impinges directly on content; when the wrong word is used, the meaning is very likely to be obscured" (1988:85).*

Another interesting finding was that although vocabulary mistakes did not always affect understanding in writing, they were deemed as inappropriate in the academic context and, overall, vocabulary errors were considered as the most important and most critical especially to professors of physical sciences. This goes in line with Heidari (2019) who concluded that knowledge of receptive and productive vocabulary is of great importance towards completion of academic studies.

Another research study by Daller and Xue (2009) conducted in a UK university institution aimed to find out how diverse or sophisticated the vocabulary of 23 Chinese students' written essays prior to arrival in the UK and their correlation with unsuccessful student outcomes. Despite the fact that the students met the criteria for admission such as adequate scores in their IELTS or TOEFL scores, this could not always secure a successful outcome (Daller and Xue, 2009). The researchers collected the participating subjects' written essays prior to their *arrival in the UK and associated their degree of success or failure during their first year of studies depending on the degree of use of infrequent vocabulary in the essay they wrote prior to their departure from China. Results from the lexical profiles from the written essays prior to students' commencement of their studies suggest that the degree of usage of sophisticated vocabulary in written essays prior to arrival can be an effective predictor of the degree of their success in their academic studies in the UK. The outcome of this study suggests that the use of infrequent vocabulary such as technical or sub-technical usage in written essays prior to the commencement of their academic studies could be a contributing factor in academic success. It is clear from the above that Daller and Xue (2009) research work highlights the significance of precise productive vocabulary usage in writing for academic contexts.*

2.6.2 Productive Vocabulary and Language Skills

Producing vocabulary can occur either orally or in the written medium (Laufer and Goldstein, 2004) and it can be often studied in combination with other skills. For instance, Hilton (2008) and Uchihara and Saito (2019) studied productive vocabulary in relation to oral proficiency and fluency. Findings on productive vocabulary led them to suggest that the higher the level of receptive vocabulary the more fluent speakers of a language would be in their productive speech. When other skills are involved such as listening or reading and writing, the relationship between receptive and productive vocabulary can be more obvious. For instance, a comparative study was conducted by Staehr (2008) on vocabulary size amongst three different skills involved in English language acquisition, namely, reading, writing and listening. A total of 88 Danish L1 subjects were recruited in the study and the Vocabulary Levels Test (VLT) (Schmitt et al. 2001) was employed as the research instrument focusing on the K2 most frequent word families (see section 3.6.7). The researcher concluded that there seems to be a statistically significant finding on the scores produced from the tasks on reading and writing skills and average findings on listening. This finding suggests that the size of vocabulary can be a contributing factor in reading and writing skills. Specific findings in the component of productive writing suggest that 52% of linguistic variety observed in their written tasks was directly associated to receptive vocabulary size. As

Staehr (2008) points out, "This [finding] confirms the importance of receptive vocabulary size for learners' writing performance, which is also indicated by the fairly high correlation (0.73) between these two variables" (2008: 145). Similar findings have been observed in Kim and Crossley (2018) study who looked into productive vocabulary by means of collecting the Test of English as a Foreign Language (TOEFL) writing tasks on a topic that required a short research from 480 subjects. Evidence from their findings suggest that 81.7% of good written essays relied on vocabulary usage (0.434), the size of the clauses and the reaction times. This finding suggests that the more sophistication in the usage of vocabulary, the higher the marks gained from the part of the examiners. This finding goes in line with Santos' (1988) who suggested that in order to produce written texts of high standards, attention to the vocabulary representing a genre is important. In addition, Kim and Crossley (2018) suggested that lexical sophistication led writers to take longer and include complex grammatical and syntactical features in writing. Therefore, it can be seen that productive vocabulary is strongly associated with the receptive vocabulary and this relationship is stronger than other skills.

Building on Staehr's (2008) study, Miralpeix and Munoz (2018) looked at the relationship between the size of learners' vocabulary and their performance on reading, writing, listening and speaking. Specifically for writing, the writing abilities that were looked at were "structure and organization, cohesion/coherence and grammar and vocabulary" (2018:11). The researchers recruited a total of 42 subjects and were tested on two computerized vocabulary size tests, namely, the X_Lex (Meara, 2005a) and the Y_Lex (Meara and Miralpeix, 2006) (see section 3.6.7). The two computerized receptive recognition tasks focus on the word form and represent the 10K most frequent words in English. The productive writing task was a short essay of 200 words in the form of a free active written essay activity where participants chose their topic title from two available topics. The researchers found that for students whose vocabulary size was above 5K, writing quality was strongly associated with higher level of productive vocabulary. Thus, it can be suggested that the larger the vocabulary size in learners, the more effectively it can be utilized in writing. In addition to this, results from the linear regression suggested a 30% prediction of the reading or writing score based on the results attributed to the receptive vocabulary size test. Although this study looked at a combination of writing skills as impacted by *receptive vocabulary size and the score for vocabulary was joint with grammatical usage, it can be considered as a modest indication of the impact of receptive vocabulary size specifically on productive vocabulary usage. It appears from the studies of Staehr (2008), Miralpeix, and Munoz (2018) that the impact of receptive vocabulary size on productive writing is significant and this relationship will be further elaborated in the following section 2.7.3.*

2.6.3 The Relationship between Receptive and Productive Vocabulary

Receptive and productive vocabulary are related types of vocabulary knowledge with receptive vocabulary having the propensity to transfer and transform into productive vocabulary. This relationship was first examined by Palmer (1921), who made a dichotomy between the ability to recognize a vocabulary item in context and the ability to remember all aspects of a word item effectively, in order to utilize it for productive activities such as writing or speaking. Specifically, productive vocabulary is a result of the accumulated receptive knowledge into productive knowledge, which was used for communication purposes (Melka, 1997). In addition, it was suggested that the spectrum between receptive and productive vocabulary consists of a number of levels, which need to be complete before productive vocabulary is achieved (Melka, 1997). This suggests that in order to produce language a number of stages need to be completed. Specifically, receptive recognition is the initial stage towards this transfer with appropriate lexical production as its' final stage (Melka Taichroew, 1982).

In terms of size, it has been claimed that receptive vocabulary may be larger than productive vocabulary (Webb, 2008). One of the reasons for this lies on the fact that using vocabulary productively is more demanding than recognizing it and learning about it receptively (Nation, 2020). Taken together, these studies support the notion that productive vocabulary is more limited and harder to master than receptive vocabulary knowledge. One reason for this lies in the fact that for the activation of receptive recognition of written texts writers need to familiarize themselves with the written form of words (orthographic form) and work towards building word meanings from that point onwards. To illustrate this, once achieving lexical recognition, the following step is to attach core meanings *to newly learnt vocabulary before enriching it with additional information. In the context of the present study, word form is associated with meaning in the form of subject knowledge, although it can be possible to access word meaning by means of decomposing words and figuring out the meaning (Nation, 2015). In this case, it can be possible to predict knowledge of meaning only from knowledge of a word's spelt form. Although this association can be assumed for receptive vocabulary, it is likely for productive usage. To put it differently, it cannot be certain that the participating subjects knew the word meaning when they took the receptive task; however, it is expected that productive vocabulary entail knowledge of meaning(s) of various depths (Schmitt, 2014). Although the bond between word form and meaning is strong and interrelated, the present study is focused on the size of both receptive and productive vocabulary, which will examine receptive and productive vocabulary capacity in terms of word form.*

On the other hand, for productive knowledge to occur a number of skills such as "association, syntax, grammatical functions, and meaning and form" (Webb, 2009, p: 364) need to be orchestrated. It becomes clear from the above that productive knowledge is a high maintenance skill which needs rich background knowledge in order to operate, compared to receptive knowledge, which can operate with as little as recognition of word form.

Interestingly, the causal role of testing of new words has been looked at in terms of its' impact on participants response. Specifically, receptive vocabulary is claimed to be larger than productive vocabulary possibly because of testing new words, which usually involves tasks that subjects have performed on a frequent basis, e.g. receptive tasks (i.e. reading tasks). In this case, receptive knowledge of a word may be stronger (Webb 2005). On the other hand, when tasks focus on productive vocabulary of new words, it can be possible that receptive knowledge will come first (Zhong and Hirsh, 2009). However, when all different kinds of productive knowledge discussed above were put to the test by Webb (2009), it was found that productive knowledge of orthography was ranked higher than other skills tested, even higher than receptive orthography. What this finding suggests is that productive knowledge of word form is one of the skills that emerges relatively earlier than other skills and it can be an early indication of productive knowledge of a word.

As discussed in this section, receptive vocabulary has the propensity to become productive depending on the degree of exposures. Lee (2003) examined the extent to which receptive vocabulary can become productive to 65 ESL secondary school subjects without previous knowledge of the target words. Productive usage in the form of a productive writing task was tested during three different times, as exemplified in Table 4 below.

Table 4. Summative Table of Lee (2003) Study.

Lee's (2003) Summary of Receptive to Productive Transfer		
Time	**Activity**	**Receptive to Productive Vocabulary Transfer %**
point 0	**receptive:** reading comprehension task **productive:** productive writing task	13.19%
after a week	**receptive:** direct instruction on word spelling, pronunciation and meaning **productive:** productive writing task	63.62%
23 days later	**productive only:** productive writing task	43.08%

As can be seen in Table 4, the highest productive vocabulary usage occurred immediately after direct instruction of its features and meanings. Yet the delayed task revealed that some but not all vocabulary was successfully retained in the longer term. In other words, some receptive vocabulary become productive over time but the process of transferring receptive vocabulary into productive is not automatic. This goes in line with Corson (1995) and Wong (2020) who claimed that receptive, or else passive, vocabulary includes words that may not be fully recognized by learners, such as words that are dormant, partially known, or used infrequently and, thus, not easily produced.

The unsuccessful transfer from receptive to productive vocabulary is also a phenomenon that needs to be considered. For instance, Michel and Plumb (2019) explored the relationship between receptive and productive vocabulary items in 95 L2 participants who speak English as a foreign or second language. They looked into assessing receptive vocabulary by means of administering Nation's VLT. Productive vocabulary was assessed by means of generating Lexical Frequency Profiles (LFP) on students' produced essays looking at the degree of *usage of vocabulary from established lists such as K1 and K2 as well as the AWL items and off list items. According to Michel and Plumb (2019), contrary to common beliefs about language learning, receptive vocabulary does not go in line with productive vocabulary. This highlight is an interesting one since so far few studies focused on the relationship and degree of correlation between receptive and productive vocabulary in English. This means that while a number of beliefs in language learning suggest a transition from receptive to productive vocabulary (Melka Taichroew, 1982; Faerch et al., 1984; Melka, 1997; Webb, 2005; Staehr, 2008; Miralpeix and Munoz, 2018), Michael and Plumb's (2019) study suggested that it is not always the case. In other words, it can be possible that receptive vocabulary will not transfer into productive vocabulary. It appears, thus far, that the area of transfer from receptive to productive vocabulary has been predominantly based on statistical data on the amount of words known by learners and research in the area is divided.*

An analysis of learning styles and their impact on the transfer between receptive and productive vocabulary could provide more insights as to the influence of this factor in vocabulary transfer. Specifically, Booth (2021b) looked at learners' relationship between mnemonic and analytic learning style (i.e. full-listing theory and the decompositional theory discussed in section 2.5.2). The researcher gathered data from 33 students of mixed non-English L1 backgrounds at an Israeli university by administering the X_Lex (Meara and Milton, 2003), the Modern Language Aptitude Test or MLAT (Carroll and Sapon, 1959) and a 250 words essay that was analysed on Cobb VocabProfiler/BNC-20 (v3.0). Findings suggest that above K2 were gained, both mnemonic and analytical skills were utilized, and the analytical skills strongly correlated with a transfer from receptive and productive vocabulary. Thus, this finding is meaningful as it suggests that learners with strong word analysis skills, such as the ability to break down word affixes and roots and deeply process word meanings and relationships can transfer vocabulary from receptive to productive more efficiently.

Thus far, it seems that productive or active vocabulary is a complex type of knowledge and it involves multiple kinds of word knowledge. In the context of medicine, a type of vocabulary that is necessary and deemed as vital for students who study in a medical department is the productive vocabulary. For instance, in

Rogulj and Čizmić (2018) study, it was found that being able to produce medical vocabulary either orally or in written was a goal that medical students were working towards achieving. Specifically, it was deemed that using the vocabulary of the discipline was a very serious matter for the subjects and their ability to understand and use medical vocabulary was something that concerned students. In the context where the present study took place, it was suggested by faculty that effective essays needed to follow the conventions of a medical journal in terms of vocabulary, style and flow, implying familiarity with the genre and expression. In this case, subjects were expected to utilize their information from journals as well as adopt their style and expression in productive writing.

2.7 Technical vocabulary

Technical vocabulary is special and different to other types of vocabulary. The defining features that distinguish technical vocabulary from other types relate to its' restricted usage within narrow areas of specialization and the specific information it conveys (Chung and Nation, 2004). In addition, a distinctive feature of technical vocabulary relates to meaning, which is narrow and it is directly related to a restricted field of expertise (Chung and Nation, 2004). Furthermore, it has the propensity to be "ubiquitous and highly frequent in professional language" (Liu and Lei, 2020: 111). Therefore, it is the case that technical word items are used within a narrow field of specialism and their meaning is limited within that field.

The technical vocabulary used in medicine is specific of the discipline and typical amongst individuals who interact in medical settings. Specifically, Sager et al. (1980) described it as the:

> *"restricted repertoire of words and expressions (often formulaic) selected from the whole language to cover every requirement within a well-defined context. An illustration of the workings of restriction is the formation of scientific concepts. Whereas the specialist user of language utilises fully the systematic structure of language, the linguistic system allows the specialist to 'pack' complex relationships into single concepts in such a way that less specialised users can 'unpack' them according to specific rules. —Electrocardiograph indicates the function of the apparatus, the measurement made and*

> *the organ it examines. 'Gastromyotomy' is the surgical cutting (-tomy) of the muscles (-myo-) of the stomach (gastro-), and there are many other compounds with each of these elements. The use of such devices is therefore a distinguishing mark of specialised languages" (Sager et al., 1980:16).*

Sager et al.'s (1980) observation on technical vocabulary enhances understanding of the concept of packing numerous meanings in few words that professionals in the field can understand is in line with the views of the present study. This goes in line with Pueyo and Val (1996), who suggested that concrete ideas and concepts could be expressed with nonconcrete yet highly sophisticated vocabulary. The technical vocabulary in EMP has been used in scientific writings aiming to achieve communication of scientific information to audience with medical expertise.

Identifying technical vocabulary in a corpus that is specific for the disciplinary area can be a challenge. This is because, as Fraser (2012) and Davies et al. (2018) explained, technical vocabulary can be expressed in three broad forms; the first one is lay technical terms, which refer to medical technical words that are used broadly in General English (e.g. pill, therapy, heart) and knowledge of General English used for daily conversation is sufficient to achieve understanding. In addition, they often form components of MWUs, which add to their technicality and complexity (e.g. complete heart block). The second category is the cryptotechnical vocabulary, which they explained it as the type of polysemous words used in day-to-day conversations, however, when utilised in medicine they acquire special connotations related to the subject. Examples of such words are pressure, section, cast. Such words might be problematic in terms of their identification by both educators and learners, possibly due to their extensive usage in everyday conversations (Davies et al., 2018). So far, it appears that both lay technical terms and cryptotechnical terms have one feature in common: they are used broadly in everyday communication and, as such, one would expect participating subjects in the present study to have achieved a degree of awareness of them by the time they join the medical department. The third category relates to fully technical words of Greek or Latin origin such as epithelium, pulmonary and cardiomyopathy. This category seems to be the most challenging for students to learn due to spelling and pronunciation difficulties it often poses on learners especially when there is lack of familiarity with Greek or

Latin (Davies et al., 2018). It is anticipated that despite the fact that both lay technical and cryptotechnical words are technical in nature, corpus analysis programs would not identify this very important feature. In the context of the present study, this does not seem to pose a significant problem given that it is geared into assessing vocabulary size and not depth (see section 2.5). This means that medical students would be familiar with the form of vocabulary used in everyday communication that might constitute the lay technical and cryptotechnical vocabulary. Given that medical students were assumed familiar with such vocabulary at the time when the present study took place, it is likely that full technical vocabulary would be identified in the corpus analysis output. For the reasons outlined above, the technical vocabulary such as lay technical vocabulary and cryptotechnical vocabulary, which have a depth of meanings (technical and non-technical) were also investigated for the purposes of the present study to some degree.

2.7.1 Significance of Technical Vocabulary for Medical Students

Familiarizing with technical vocabulary is a necessity for medical students who begin their studies in medicine. This is due to the fact that technical vocabulary appears frequently in specialized disciplines, thus, it makes it necessary for individuals who are working or studying learning materials in specialized disciplines to acquire it (Liu and Lei, 2020). Thus, anyone who wishes to get involved in a discipline such as medicine would need to acquire the relevant technical vocabulary, which may be used only in medicine or related fields and no other academic or professional discipline. This is a typical characteristic of technical vocabulary, which is specifically reserved for use in one discipline (Chung and Nation, 2004, Nation, 2008, 2013; Coxhead, 2013). Technical vocabulary is used typically in order to encapsulate specific information that is particular of a discipline (Liu and Lei, 2020). Owing to this, it has the propensity to be acquired by specialists in a field who practice a specific profession (Coxhead, 2018). In addition, technical vocabulary is key in order for someone to enter a specific group of individuals with specific interests. In addition to this, awareness of technical vocabulary has been linked with scientific awareness (Woodward-Kron, 2008; Yuksel and Mercanoglu, 2010; Gablasova, 2014b).

In addition, when mastered, technical vocabulary can be used to identify new medics within the medical speech community. In most cases, it is individuals who engage with one specific disciplinary area and belong to a "system of subject knowledge" (Chung and Nation, 2003:252). This suggests that subjects who studied or occupied themselves with the discipline are typically familiar with its technical vocabulary. Their awareness of technical vocabulary along with related disciplinary information makes them members of a community, which shares the same scientific background, and medical students can access and produce discourse in that domain (Coxhead, 2013; Woodward-Kron, 2008). This was further elaborated by Coxhead (2013) who suggested that:

> *"People outside that academic or professional sphere might have some knowledge of this vocabulary but the people inside these areas of language use would be expected to be able to understand and use this language fluently" (Coxhead, 2013:116).*

This suggests that usage of technical vocabulary typically occurs between individuals who specialize in an area of expertise. In the case of technical vocabulary of medicine, one would expect that it would be introduced during medical studies and used by professionals in health care.

In the medical context, awareness of technical vocabulary is important for both L1 and L2 medical students and practicing healthcare professionals in order to acquire the subject knowledge and communicate it with their colleagues. This is because accurate use and understanding of technical vocabulary can make communication between its members more efficient, therefore, improving the quality of health services. In addition to this, in the case of L2 subjects it can open up a possibility towards seeking employment overseas.

2.7.2 Etymological Features of Technical Vocabulary

As discussed in section 2.6, one of the reasons that result in learning difficulty of medical vocabulary relates to etymology specifically due to derivations from classical languages such as Greek and Latin. In the area of technical vocabulary in medicine, Cabrita et al. (2014) suggested that such derivatives are present in affixes and a simple etymological analysis can break down a number of meanings in a word.

> *"technical or specialized terms derived from Greek and Latin, vastly increased by the use of prefixes, suffixes and compounds" [...] "Greco-Latin morphemes provide the basic building blocks of medical terminology and enable us to infer the meaning of innumerable medical terms, be they in English or in most European languages, by going back to their etymology - e.g. haematuria means blood (haem-) in urine (-uria), laparotomy, incision (-tomy) in the abdomen (laparo-)" (Cabrita, 2014:349-350).*

It appears from the above that Greek and Latin is present in medical affixes and morphemes, thus, creating novel words which carry specialized meanings. In addition to affixes and morphemes, grammar deriving from Greek and Latin is used in medical vocabulary (Van Hoof, 1998). For instance, some plural forms of technical vocabulary may be irregular due to Greek or Latin irregularities as in thorax/thoraces, carcinoma/carcinomata, viscus/viscera. In addition, a blend of Greek and Latin forms is also possible in technical vocabulary as in the case of the term hypnic which is based on the Greek stem ύπνος *(hypnos) and the Latin ending (-ic). Furthermore, it is not uncommon for entire words from Greek or Latin to remain intact in medicine in such as* κίρρωση *(cirrosis) (=inflammation in the liver), ante cibum (=before food, usually abbreviated as a.c.) and oculus dexter/sinister (right/left eye, usually abbreviated as od and os accordingly). Thus far, it is evident that medical technical vocabulary includes numerous etymological features and phenomena that originate from classical languages.*

In addition, the etymology of technical vocabulary in medicine includes elements from a range of other sources. For instance, Wermuth and Verplaetse (2018) considered that a number of other influences have affected the etymology of technical vocabulary in English. These were "words from general language, abbreviations and acronyms, eponyms, slang and jargon words (partially derived from terms), synonyms, metaphors and metonyms, and made-up words" (Wermuth and Verplaetse, 2018: 87). It appears that technical vocabulary used for medical purposes includes a mix of a number of linguistic features that form part of its etymology, thus, making it a unique type of vocabulary.

Moreover, the etymology of medical vocabulary is often influenced by technicalization as a result of its constant evolution. Since medicine is a growing field with more and more technical terms being created aiming to express objective and specific meanings, more technical words are generated as a result. During the process of technicalization, which involves generating new technical terms, or neologisms, a number of etymological features are used to add technical meanings. For instance, new medical terms can be generated by adding a Greek prefix, such as neo (= new) in already existing medical terms such as: neogenetic (<neo+genetic), neoarthrosis (<neo+arthrosis) and neoplasia (<neo+plasia). In the examples provided, the prefix neo suggests something new that did not exist before; thus, neogenetic refers to the generation of new biological tissue, neoarthrosis refers to a new joint created after an unhealed fracture and neoplasia refers to a new tumor that suddenly appears in the body. As can be seen in the examples above, the prefix neo has a standard meaning and when it is coupled with different morphemes, it can be used to describe various new health conditions. Thus, the etymology of technical vocabulary is affected by a number of variables discussed in this section during the process of technicalization aiming to enhance scientific communication between members of the discipline in a clear, concise and objective way.

2.7.3 Research in the area of Technical Vocabulary of Medicine

As mentioned in the previous section 2.8.2, technical vocabulary presents a number of idiosyncratic features in its etymology, thereby, making it an interesting field for linguistic research. This sparked interest from as early as 1823 when Wakely investigated texts from Medical Research Articles (MRAs) and provided suggestions for improvements (Maher,1986). Another historic study was conducted in 1895 on technical vocabulary and was included in the Basel Nomina Anatomica (BNA), which is one of the first documented medical vocabulary lists, generated, revised and approved internationally at the time (Roberts, 1980). Until recently, similar types of research studies focused mainly on medical text analysis were conducted, as discussed in the present section.

One of the first studies that particularly looked only into the technical vocabulary of medicine was Chung and Nation’s (2003). The researchers aimed to focus only on technical vocabulary appearing in texts in medical anatomy and applied linguistics. To identify the technical vocabulary, they devised the semantic rating scale. The rating scale included four steps is illustrated in Table 5.

By classifying the vocabulary they encountered in anatomy and applied linguistics textbooks in each of the Steps, Chung and Nation (2003) found that technical vocabulary fell into Step 4 of the rating scale in medical texts. On the other hand, applied linguistics texts fell into Step 3. This finding was indicative of the relative degree of narrowness of technical vocabulary used in medicine. One explanation for this finding relates to the denser nature of medical texts compared to applied linguistics texts in terms of technical vocabulary usage. This was further documented by Nation (2003) who mentioned, "Almost one out of every three words in the anatomy text (31.2%) is a technical term" (2003:109), unlike applied linguistics textbooks, which had one technical word in every five words. Thus, it is evident that in Chung and Nation's (2003) study, medical texts seem to be demanding to students who intend to use them for their learning.

The use of the rating scale was established in a follow-up study from Chung and Nation (2004) which looked at standardizing the Rating Scale as a procedure for identifying technical vocabulary in medical texts. More specifically, the researchers highlighted advantages of the rating scale as a technical term identification tool which were mainly the interrater agreement and the opportunity to observe how lexical items function in a sentence, which enhances reliability. Another effective way that can assist with the identification of technical terms was the use of digital corpus analysis, which offers the opportunity to analyze the degrees of word frequency and range, see section 2.9.2.

The third method proposed was the analysis of textual cues such as definitions and punctuations, which was considered as ineffective as punctuations can have a number of uses apart from introducing technical terms in a sentence. The forth method was the dictionary approach, which was considered as time consuming, particularly in the field of anatomy. Although the corpus analysis was considered as effective, it lacked critical selection of word items since the analysis was run on a digital software. Therefore, the researcher would intervene as certain word items were identified as technical terms where they were collocates of a term. Finally, the semantic rating scale was considered as the most effective way to identify technical vocabulary in texts; however, it is difficult to apply in larger texts with millions of word items.

Table 5. A Rating Scale for Finding Technical Words. Extract from Chung and Nation (2003:105).

Step 1 Words such as function words that have a meaning that has no particular relationship with the field of anatomy, that is, words independent of the subject matter. Examples are: *the, is, between, it, by, 12, adjacent, amounts, common, commonly, directly, constantly, early,* and *especially.*
Step 2 Words that have a meaning that is minimally related to the field of anatomy in that they describe the positions, movements, or features of the body. Examples are: *superior, part, forms, pairs, structures, surrounds, supports, associated, lodges, protects.*
Step 3 Words that have a meaning that is closely related to the field of anatomy. They refer to parts, structures or functions of the body, such as the regions of the body and systems of the body. Such words are also used in general language. The words may have some restrictions of usage depending on the subject field. Examples are: *chest, trunk, neck, abdomen, ribs, breast, cage, cavity, shoulder, girdle, skin, muscles, wall, heart, lungs, organs, liver, bony, abdominal, breathing.* Words in this category may be technical terms in a specific field like anatomy and yet may occur with the same meaning in other fields and not be technical terms in those fields.
Step 4 Words that have a meaning specific to the field of anatomy and are not likely to be known in general language. They refer to structures and functions of the body. These words have clear restrictions of usage depending on the subject field. Examples are: *thorax, sternum, costal, vertebrae, pectoral, fascia, trachea, mammary, periosteum, hematopoietic, pectoralis, viscera, intervertebral, demifacets, pedicle.*

This was a realization that Quero (2017) had when she looked into the vocabulary load of medical textbooks beyond the GSL (West, 1953), the AWL (Coxhead, 2000) and the EAP Science List (Coxhead and Hirsh, 2007) in order to better understand the vocabulary demands that L1 and L2 undergraduate students of medicine are required to respond to. In order to conduct her study she decided to combine the advantages of corpora analysis and the semantic rating scale. Specifically, she compiled two corpora from medical textbooks of 5.4 million tokens each. The first corpus based on medical textbooks was a General English corpus used as a mirror corpus. Then, she analyzed the two corpora on the RANGE software together with wordlists such as the GSL, the AWL and the EAP Science List. It should be mentioned here that at the time of data analysis, the new-GSL (Brezina and Gablasova, 2015) was not available. To identify the technical vocabulary in her output, any word item that did not correlate with the previous wordlists and General English corpus was analyzed manually using the semantic rating scale. Her findings suggest that 3,000 words were General English word types with a medical meaning and 23,000 words were medical word types up to 98% of lexical coverage. This study offered an opportunity to observe the significant vocabulary load that medical textbooks carry and the demands they pose on medical students. The resulting corpus output based on 26 thousand word items aimed to reach 98% of text coverage and provided a suggestive wordlist. This may be of benefit to learners and teachers of EMP. Quero (2017) suggested that her technical vocabulary wordlist indicates a large number of word items that medical students need to be acquainted with in order to read the textbook materials of medicine effectively reaching 98% of lexical coverage. One of the limitations of this study is the fact that it focused solely on textbooks and did not include other sources of medical information (for example, see section 2.3). Despite its' limitation, Quero's (2017) study effectively aimed at suggesting a combined methodology and a resulting wordlist that can be of benefit for EMP.

Furthermore, Quero's (2017) study followed her doctoral project (Quero, 2015), which looked at comparing the vocabulary load of medical textbooks against participants' vocabulary level at the time of their initial semester of medical studies. A total of 408 L1 Spanish first year students of medicine from Venezuela *were given the standardized Vocabulary Size Test (VLT) (Nation and Beglar, 2007) to measure their receptive vocabulary size. Then, a comparison between the vocabulary load of medical textbooks and medical students' level of competence was carried out in Quero (2017). The findings on the receptive vocabulary suggest that the participants' knowledge of word families was at the level of 6,000 at the time of data collection. Data suggest that in order to reach a sufficient level of understanding of a text which was set at the 98% level, medical students should gain awareness of additional 26,000 word items specialized to the medical field. This study was of particular significance in the field since it involved real students of medicine and looked at their learning needs to respond to the program effectively. One of the weaknesses of this study lies on the fact that it could be possible that the medical students she recruited possibly had a lack of awareness of General English word items, yet they might outperform in medically related vocabulary. This argument was further supported by Daniele (2015) who claimed that it is possible for L2 medical students to encounter specialized vocabulary frequently in the textbook materials they study for their course and excelled in medical vocabulary, unlike General English vocabulary.*

In addition, Ripamonti's (2015) study of the grammatical and collocational background surrounding technical terms in medicine looked at technical vocabulary in a medical corpus (MedEnCor) of 3,575,522 running words. The corpus was compiled from a selective number of resources from specialities such as endocrinology, gastroenterology, hematology, nephrology and rheumatology and included samples from genres such as: "research articles, abstracts, guidelines, case reports, editorials, clinical trials, patient information leaflets, doctor-to-doctor forums and blogs" (2015:128). The researcher created a frequency and keyword list by utilizing the software WordSmith Tools and mirrored the corpus output with the BNC basewords. She then moved on to utilize the RANGE software to identify the technical vocabulary from the General English vocabulary items and further investigated the collocation function of each of the 19 technical items in her vocabulary list by looking at the collocates 5 words to the right and 5 words to the left of each technical item. By investigating the collocational behaviour of each of the technical word items, she included additional vocabulary in her wordlist as well as information regarding grammatical patterns of each vocabulary item. Her study is useful as it suggests *ways in which dictionary writers' work in order to present medical vocabulary using authentic context in their dictionaries and by utilizing corpora applications.*

Another study that looked into the technical vocabulary of anatomy texts (Gray's Anatomy for Students) was conducted by Fraser et al. (2016) in an effort to generate a wordlist with the most frequent items occurring in it. The wordlist was suggested to be utilized for pedagogical purposes to help Japanese medical students focus on the most frequently occurring vocabulary first. To this end, the researchers generated a corpus of 361,087 running words and analyzed it on Antconc 3.2.4. Findings suggest that the most frequently occurring vocabulary in the anatomy textbook was a 500 tokens wordlist, a 353 two-word items list and a 100 three words items list. Fraser et al. (2016) resulting wordlist was intended to meet the needs of Japanese learners studying technical vocabulary only from textbook materials particularly in the area of anatomy and to this end, together with technical vocabulary, they added General and sub-technical vocabulary in their wordlist.

It appears that the area of technical vocabulary in medical textbooks has been approached from multiple perspectives. Apart from the perspective that the present thesis intends to approach, the technical vocabulary in medical textbooks has been studied in other types of studies. For instance, diachronic studies looking into old textual data, such as the technical vocabulary used in ophthalmology texts (Ramos, 2006), the study of three specific technical terms in Middle English and their diachronic use towards the contemporary standard use in medical terminology (Sylwanowicz, 2014) and the study of technical terms in Traditional Chinese Medicine (Cailing, 2018). Furthermore, studies related to the investigation of technical vocabulary in medicine and the influence of certain languages in it, for example, Czech (Bozdechová, 2006), Croatian (Seljan, 2014) and Polish (Marciniak and Mykowiecka, 2014). Other kinds of studies investigated the technical vocabulary in medicine in relation to the development of digital software such as the automated corpus generation for analogical recognition of two texts (Abacha et al., 2015) and the development of an automatic technical terms explanation program in English and Spanish (Kloehn et al., 2018). Finally, technical vocabulary has been investigated in other disciplines related to medicine such as pharmacology (Yuksel and Mercanoglu, 2010) and dentistry (Perkhach et al., 2020).

It is evident from the above that technical vocabulary is an area that so far received a considerable research interest. In addition to studies on the medical technical vocabulary, other studies on technical vocabulary have been conducted in other disciplines. For instance, Coxhead and Demecheleer (2018) found that in Plumping texts, 35.58% of their running words were technical and in a similar study in Fabrication texts Coxhead et al. (2019) found that 30.47% of the running words were technical. As far as the spoken discourse of a discipline is concerned, Coxhead et al (2020) found that one in ten words is technical in vocational texts and Coxhead and Demecheleer (2018) spoken data from Plumping suggested that 12.7% of the discourse included technical vocabulary. In addition, Coxhead et al. (2018) found that 9.18% of spoken data in oral fabrication discourse was technical. This suggests that technical vocabulary is present not only in medical texts but also in other disciplinary skills and fields, thus, verifying the trend to use technical vocabulary in fields of discipline related to a number of scientific and professional areas.

2.8 The Sub-Technical Vocabulary of Medicine

This section aims to present illustrations on what sub-technical vocabulary is and develop its' theoretical framework that will be adopted in the present study. Sub-technical vocabulary is synonymous to semi-technical (Farrell, 1990) vocabulary as well as academic vocabulary (Wang et al., 2008; Nation, 2016). Based on Baker's (1988) and Robinson's (1991) comprehensive review of sub-technical vocabulary classification, the sub-technical vocabulary relates to the type of vocabulary that is often shared between a number of scientific disciplines in order to facilitate the structure and coordinate academic texts but is not always part of General English (GE) vocabulary. The sub-technical vocabulary is not a new concept in ESP as it has been studied for a number of years. Its challenging nature was noted by Baker (1988) who stated that the sub-technical vocabulary could cause significant difficulties to readers of medical texts in terms of comprehension and evaluation. A more comprehensive account of the sub-technical vocabulary was suggested by Baker (1988). Specifically, the researcher considered that the sub-technical vocabulary cannot be considered neither as a General English nor as a discipline-specific vocabulary:

> *"sub-technical" [vocabulary] as a category has proved to be elusive and confusing for many teachers, the reason being that the term has neither been clearly nor consistently defined in the literature. Moreover, it is as simplistic as the specialised/general division in that it attempts to classify anything that is neither specialised nor general under the same heading. Common sense and experience indicate that this middle area between specialised and general [vocabulary] is itself made up of several different types of vocabulary" (Baker, 1988: 91-92).*

Another view of sub-technical vocabulary was suggested by Hsu (2013) who defined sub-technical vocabulary as: "a class of words between technical and non-technical words and usually has technical and non-technical implications. It covers lexical items that are neither specific to a certain field of knowledge nor general in the sense of being everyday words." (Hsu, 2013:457). The definition provided by Hsu (2013) on sub-technical vocabulary goes in line with the aims from the present thesis. For the purposes of the present study, sub-technical vocabulary will be considered as the kind of vocabulary that is not frequently encountered in lay contexts and is shared between academic disciplines. Although the sub-technical vocabulary is shared amongst academic disciplines, it can be argued that each discipline e.g. medical discipline may use its' own sub-technical vocabulary and expression, which is what the present study is looking at.

2.8.1 Research Studies on the Sub-technical Vocabulary of Medicine

Similarly to technical vocabulary research works (see section 2.8.3), sub-technical vocabulary studies are relatively new and focused on textual analysis often resulting in recommended wordlists with limited interest on actual medical students. Given that there is no study so far conducted on medical students' sub-technical vocabulary, this section reviews studies that have been conducted in the field of medical sub-technical vocabulary so far.

The sub-technical vocabulary was studied by researchers such as Wang et al. (2008) who conducted a corpus-based study with the intention of producing a suggestive wordlist with target words that medical students should be introduced to during their EMP courses. In Wang et al.'s (2008) study, the aim was to investigate the sub-technical type of vocabulary that appeared frequently in medical writings in order to inform EMP instructors on the kinds of words that *they should focus on first. To achieve this, the researchers compiled a corpus from 288 Medical Research Articles, which totaled 1,093,011 running words. Their suggestive word list called Medical Academic Word List (MAWL) had a total of 623 word families and claimed to cover 12.24% of medical academic texts. Their wordlist included disciplinary vocabulary and was intended to be utilized for EMP learning and teaching purposes. The MAWL was criticized by Hsu (2013), who found that it included 342 similar word items to Coxhead (2000) AWL, leading the author to suggest that the real suggestive vocabulary from the MAWL is 281 word items.*

Then, Hsu (2013) suggested an improved sub-technical wordlist for medical purposes, the MWL (Medical Word List). The researcher aimed to find out the sub-technical vocabulary in her medical corpus by means of corpus comparison. To this end, she generated a large corpus of 15 million running words from 155 medical textbooks covering 31 medical sub-disciplines that were available in digital form. The medical corpus she compiled was analysed together with the BNC wordlists. By running a corpus comparison of her medical corpus and using the BNC as a mirror corpus, the researcher identified the sub-technical vocabulary in her medical corpus by observing the word types that overlapped the BNC4-BNC14 wordlists. Vocabulary below the BNC4 was classed as General English in line with Schmitt and Schmitt (2014) and vocabulary beyond the BNC14 including the off-list items, which relate to vocabulary that did not appear in the BNC corpus, (e.g. retina and pituitary) were classed as technical. This division is a meaningful one because it demonstrates a methodological practice in which corpus comparison has the potential to detect variation in tokens in large corpora. The resulting MVL included 595 sub-technical vocabulary items and claimed a 10.72% of lexical coverage in medical textbooks. Although Hsu (2013) had made an effort to conduct a large corpus investigation on the medical sub-technical vocabulary, she admitted that her MVL overlapped the AWL by 76 word items. At a later study, Hsu (2018) focused on the sub-technical vocabulary of Traditional Chinese Medicine (TCM) following similar methodology through the compilation of 135 related textbooks of 13-million running words and generated a list of 605 running words suggestive of the sub-technical vocabulary appearing in TCM texts.

In addition, Mungra and Canziani (2013) conducted a research study on the sub-technical vocabulary of case reports (both medical and surgical) in published academic sources. A corpus of 72 documents reflecting 24 medical sub-disciplines from authors affiliated with English speaking universities was compiled. The researchers ran the RANGE software and for their analysis they considered word items appearing in half the disciplines and had a frequency of 30 for the generation of the Medical Academic Word List for Clinical Cases (MAWLcc) consisting of 720 items. A comparison with already established wordlists such as Coxhead's (2000) AWL suggested an overlap up to 85%. This suggests that a total of 498 word families from the MAWLcc were similar with the AWL-570 word families. In addition, there was a 38.25% or 153 word families overlap with Wang et al's MAWL. This finding suggests that the overlapping with the MAWL and AWL is sufficient evidence to suggest that the two wordlists have the potential to prepare medical students sufficiently to encounter clinical reports in English on their own. These findings led the researchers to suggest that the clinical case reports do include academic word items and they proposed the MAWLcc as a reference for teachers and students of EMP.

Another significant contribution to the field of sub-technical vocabulary is Gardner and Davies (2014) study, which offered an up-to-date academic wordlist aiming to supplement some weaknesses that Coxhead's (2000) AWL had. Specifically, the researchers generated the Academic Vocabulary List (AVL) from contemporary and larger text samples of 425 million tokens compared to Coxhead's (2000) AWL, which was based on a 3.5 million tokens corpus. In addition, the scientific disciplines represented in their corpus were nine while in the AWL they were four. The final AVL was lemmatized aiming to target specific derivatives that are used in academic discourse. Unlike Coxhead's reliance on already established wordlists such as the GSL, Gardner and Davies (2014) did not take this into consideration in the generation of their AVL on the ground that vocabulary from the GSL tends to occur in academic discourse as well and, as such, it needs to be highlighted to EAP students. Another characteristic that makes the AVL useful for learning and teaching is its higher text coverage in academic discourse texts. More specifically, it was shown by Gardner and Davies (2014) that the AVL had a 13.7% to 13.8% of lexical coverage compared to the AWL, which was 6.9% to 7.2%. In addition, the researchers generated an online platform where the AVL is represented and collocations of AVL items can be *studied. The AVL is considered as a reliable vocabulary list for academic purposes to date. It may appear considerably lengthier (3,000 word lemmas) than the AWL (570 word families), however, this difference may be negligent due to the fact that each of the two wordlists implemented a different unit of counting vocabulary items (see section 2.9.1). Overall, the AVL seems to be a more recent academic wordlist which includes sub-technical vocabulary from a larger number of scientific fields and based on a larger corpus given the advancements in technology and corpus analysis that have occurred 14 years after the AWL publication.*

Following Gardner and Davies (2014) example of data collection and analysis and combining it with Coxhead (2000) word frequency suggestions, Lei and Liu (2016) studied the sub-technical vocabulary in medical textbooks and journals. The researchers compiled a corpus from 2.7 million running words from journal sources and a 3.5 million running words from textbooks. Their research includes a few points that remain unanswered by Lei and Liu (2016) such as exactly how many textbooks or journals have been used to conduct their research study and who suggested the references included in the corpus. As the researchers directed the resulting wordlist for actual medical students and students who prepare to study medicine, it could have been ideal to consider the learning and teaching resources suggested by medical instructors for beginning medical students to ease them into the science. The researchers managed to gather a representative number of resources from 21 disciplines representing medicine. By adopting Gardner and Davies (2014) analysis protocol discussed in the previous paragraph along with Coxhead (2000) frequency suggestions, the researchers developed the Medical Academic Vocabulary List (MAVL). The wordlist consists of 819 word items, it is shorter and it claims a higher percentage of lexical coverage in medical texts than Wang et al. (2008) MAWL. Lei and Liu's (2016) MAVL included both sub-technical vocabulary items and general vocabulary that carries specialised meanings in medicine such as best, adult and test. Compared to Wang et al. (2008) MAWL, the MAVL was shorter by 53% and had an 80.95% of lexical coverage, which was greater than MAWLs degree of coverage. Lei and Liu's study managed to join two influential authors' techniques effectively, namely, Gardner and Davies (2014) and Coxhead (2000) and chose the best of both techniques in order to generate a wordlist that demonstrates the most frequently occurring medical vocabulary in medical academic textbooks. This makes Lei and Liu (2016)

MAVL a more up-to-date sub-technical wordlist compared to Wang et al. (2008) MAWL.

In the field of Traditional Chinese Medicine (TCM), Lu and Durrant (2017) conducted a comparative study analysing the degree of coverage of Coxhead's (AWL) and Gardner and Davies' (2014) AVL in TCM research articles written in English. The researchers found that the AVL had 21.17% of lexical coverage compared to the AWL, which was significantly lower (10.64%) in TCM research articles texts. In order to supplement the need for academic vocabulary with higher lexical coverage in this discipline and assist learners and teachers of TCM, the researchers proposed a wordlist with additional lexical items that were closely related to the field. This study is unique as it assessed the two established academic wordlists including sub-technical vocabulary and extended their effectiveness by proposing more linguistic items that were typical of the TCM area of scientific study.

In addition, Dang, Coxhead and Webb (2017) conducted a meaningful study in the field of spoken sub-technical vocabulary. The researchers looked into spoken discourse and aimed to generate a wordlist based on the spoken academic discourse. This is because the researchers believed that already existing wordlists based on written corpora "may not be representative of academic spoken vocabulary" Dang, Coxhead and Webb (2017: 965). Therefore, the researchers utilized four corpora to develop their Academic Spoken Word List (ASWL) as reported in Table 6. As can be seen in Table 6, Dang et al. (2017) made a significant effort to validate her wordlist against corpora of thousands of words. The resulting ASWL reflected a total of 24 disciplines and by means of comparing the word frequency, range and dispersion, the researchers concluded with a wordlist in the form of lemma. The list is user friendly as it is divided into different levels depending on students' ability in order to help guide the students and instructors towards the vocabulary that is appropriate according to learners' current level of competence.

The proposed wordlist can be useful for learners with a low level of English such as L2 learners who studied English for a limited period of time and wish to advance their vocabulary to be able to access academic speech. However, when it comes to the medical context, the wordlist claims to cover only 89.46%, which is *below the optimal level for adequate understanding, which was proposed to be on the range of 98% (Nation, 2006).*

Table 6: The ASWL Corpora. Source: Dang, T., N., Y., Coxhead, A. and Webb, S. (2017) The academic spoken word list. Language Learning 67 (4), pp.959-997, page. 967.

The ASWL Corpora		
Corpus	**Purpose**	**Size (running words)**
First Academic Spoken Corpus	to develop the ASWL	13,029,661
Second Academic Spoken Corpus	to determine if the ASWL accurately reflects the vocabulary in academic speech	12,740,619
Academic Written Corpus	to examine if the ASWL reflects writen vocabulary	13,449,584
Non-academic Spoken Corpus	to examine if the ASWL reflects academic vocabulary	13,863,628

A follow up study from the main researcher, Dang (2018a), looked into the sub-technical vocabulary of the hard sciences such as mathematics, medicine, biology and engineering. The researcher focused on the spoken genre within academic settings by means of compiling a 6.5 million running words corpus from a number of already compiled corpora such as the British Academic Spoken Corpus and the Michigan Corpus of Academic Spoken corpus, to name just a few, representing 12 sub-disciplines in total. The resulting Hard Science Spoken Word List (HSWL) includes 1,595 items in the form of lemma and covers 90.94% and 90.82% for a 95% and 98% of lexical coverage respectively within the hard sciences settings it represents. This study highlighted the need for hard academic sciences to focus on vocabulary that is predominantly occurring in hard sciences rather than other soft sciences. However, this percentage is not different from the Academic Spoken Word List (ASWL) developed by Dang et al. (2017). Specifically, it claims a 90.24% and 89.84% for a 95% and 98% of lexical coverage respectively *in academic spoken settings. In a follow-up study, the author (Dang, 2018b) compared the HSWL with the Soft Sciences Word List (SSWL) and concluded that the first 3,000 words are vital in the area of soft sciences. The researcher developed her word list in the form of "flemmas" (Dang, 2018b: p.12) which is a hybrid word list in the form of lemma without focusing on the word families. Her resulting 1,964 running words SSWL had a significant overlap with BNC/COCA1-BNC/COCA3 words. Although this wordlist could be useful for learners who intend to enrol in soft science courses with knowledge of less than 1 thousand words, it is of limited usage for learners of levels higher than the 1,000-3,000 BNC/COCA words. The comparison between the SSWL with the HSWL concluded that the HSWL included vocabulary beyond the limits of SSWL, suggesting that the HSWL was more complicated in terms of vocabulary, perhaps due to the nature of the subjects it covers.*

Another study that looked into the sub-technical vocabulary from a medical sub-discipline, pharmacology, was conducted by Heidari et al. (2020). By compiling a 3,458,445 running words corpus from pharmacology journals, reviews and notes from four pharmacy sub-disciplines, the researchers generated the Pharmacology Academic Word List (PAWL) consisting of 750 word families, which covered 17.69% of the corpus. They concluded that their wordlist was more effective than the MAWL or the AWL due to the fact that they did not seem to provide as much coverage in pharmacology texts as the PAWL. Although the AWL covered 9.28%, it seems that the PAWL was not very different from the MAWL in terms of coverage as the MAWL covered 16.07% of the corpus. This study proposed a wordlist for materials developers and EMP instructors with specific vocabulary to work on in pharmacology. Although Heidari et al. (2020) did not make explicit references to technical or sub-technical division in their vocabulary research, it seems that their study was leaning towards the sub-technical vocabulary since they mentioned that they did not focus on General English vocabulary and at the same time, they did not consider technical vocabulary for the generation of their PAWL.

The sub-technical vocabulary in disciplinary studies has also been looked at in other sciences apart from medicine. For instance, examples of which are engineering (e.g. Hsu, 2014) and law (e.g. Pérez, 2016). The main rationale for conducting these studies was the generation of sub-technical vocabulary wordlists in order to guide ESP instructors on what vocabulary to focus on first. Although *the present thesis shares some of the principles for generating and disseminating sub-technical vocabulary from corpora (see section 2.9), the main goal was to examine receptive and productive density and apply some principles of language data analysis from corpora to generate a receptive task for medical students to complete, as discussed in Chapter 3.*

2.9 Identifying Technical and Sub-technical Vocabulary in Texts

Technical and sub-technical vocabulary are typical in disciplinary texts (Nation et al., 2016). As the present study looks into studying these two types of vocabulary it is important to reflect on ways of identification of technical and sub-technical vocabulary in medical texts so far.

The technical and sub-technical vocabulary have been mainly approached and explored in two ways: the semantic rating scale and corpus analysis and, more recently, POS tagging and python techniques (Lei and Liu, 2016). Table 7, illustrates a brief summary of a selection of studies featured in the present thesis, which dealt with the technical and sub-technical vocabulary appearing in the medical written form (see sections 2.8 and 2.9). First, the semantic rating scale was not frequently used in specialized vocabulary analysis. This was often related to the fact that some studies were geared towards the generation of a medical wordlist for learning and teaching purposes while other studies were aiming to explore the degree of technicality in medical texts. A more recent technique involved Part of Speech Tagging (POS) in combination with a computer programming package (Liu and Lei, 2016), which is a new technique for identifying lemmas in their study. It appears from Table 7 that the most common identification method was the implementation of automatic linguistic analysis such as corpora applications.

Baker (1988) was the first to provide a systematic direction of how sub-technical vocabulary should be identified in medical texts and it is a good starting point as to what should or should not be considered sub-technical vocabulary. Specifically, Baker (1988) defined six criteria for the identification of sub-technical vocabulary:

> 1. "items which express notions general to all or several specialized disciplines,
>
> 2. items which have a specialized meaning in one or more disciplines, in addition to a different meaning in general language,
>
> 3. items which are not used in general language but which have different meanings in several specialized disciplines,
>
> 4. items which are traditionally viewed as general language vocabulary but which have restricted meanings in certain specialized disciplines,
>
> 5. general language items which are used in preference to other semantically equivalent items to describe or comment on technical processes and functions,
>
> 6. items which are used in specialized texts to perform specific rhetorical functions. These are items which signal the writer's intentions or his evaluation of the material presented" (1988:92).

The framework for identification of sub-technical vocabulary proposed by Baker (1988) synthesises the way that sub-technical vocabulary has been portrayed by a number of scholars. For instance, the first statement reflects the views of Dudley-Evans (1985) and Coxhead (2000), who emphasized the prevalence of sub-technical vocabulary in all academic fields. In addition, sub-technical vocabulary seems to have a more limited use within a field of expertise as exemplified in the second and forth statement in line with Kennedy and Bolitho (1984), Trimble (1985) and Hsu (2013; 2018). Moreover, a more disciplinary discourse-oriented description is provided in statements n. 5 and n. 6 associated with the lexical function of words in discourse organization (Martin, 1976; Winter, 1977; 1982; Francis, 1986; Widdowson, 1983; Robinson, 1988; McCarthy, 1991). An additional feature that was considered for the purposes of the present study involves implementing the statistical density output from corpora analysis (i.e. frequency and range) (Barber, 1962; Inman, 1978; Farrell, 1990).

Table 7: Summary of Featured Studies in Sections 2.8 and 2.9.

Summary of Featured Studies Discussed in Sections 2.8 and 2.9				
Type of Vocabulary Investigated		Author	Identification Method	Outcome of the Study
TECHNICAL VOCABULARY	vocabulary in medical research articles	Baker (1988)	devised scale	raise awareness of the possibilities that the field offers in learning and teaching
TECHNICAL VOCABULARY	medical & applied linguistics textbooks	Chung and Nation (2003)	Semantic Rating Scale	medical anatomy textbook:31.2% or (1 in every 3 words was technical); applied linguistics texts: 20.6% (1 in every 5 words was technical)
TECHNICAL VOCABULARY	four methods for identification of technical vocabulary in texts	Chung and Nation (2004)	a. the semantic rating scale; b. corpus analysis; c .textual cues; d. the dictionary approach	1.the semantic rating scale: reliable but ineffective for long texts 2.corpus analysis: pros: study word frequency and range but it cannot interpret findings 3.textual cues: was found ineffective 4.the dictionary approach: was found time consuming
TECHNICAL VOCABULARY	vocabulary in medical research articles	Wang *et al.* (2008)	Corpus Analysis	sub-technical vocabulary wordlist MAWL of 623 word families
TECHNICAL VOCABULARY	vocabulary of medical textbooks	Hsu (2013)	Corpus Analysis (RANGE Software)	sub-technical vocabulary wordlist MVL of 595 vocabulary items
TECHNICAL VOCABULARY	vocabulary of Medical case reports	Mungra and Canziani (2013)	Corpus Analysis (RANGE Software)	MAWLcc consisting of 720 word items
SUBTECHNICAL VOCABULARY	identification in medical texts	Ripamonti (2015)	Corpora: WordSmith Tools and the RANGE)	sub-technical vocabulary word list and their collocates
SUBTECHNICAL VOCABULARY	medical textbooks	Quero (2015)	1.Corpus Analysis (RANGE) 2.Semantic Rating Scale	36% of the medical textbooks vocabulary was technical
SUBTECHNICAL VOCABULARY	vocabulary in anatomy textbook	Fraser *et al.* (2016)	Corpus Analysis (Antconc 3.2.4m)	sub-technical vocabulary word list
SUBTECHNICAL VOCABULARY	vocabulary in medicine	Lei and Liu (2016)	POS tagging and Python	sub-technical vocabulary wordlist MAVL
SUBTECHNICAL VOCABULARY	vocabulary in oral English from 24 disciplines	Dang, Coxhead and Webb (2017)	RANGE software	Sub-technical vocabulary wordlist Academic Spoken Word List (ASWL)
SUBTECHNICAL VOCABULARY	load of medical textbooks past GSL/AWL/EAP SL	Quero (2017)	Corpus Analysis (RANGE software) Semantic Rating Scale	to reach 98% of text coverage learners should acquire 26K technical word items
SUBTECHNICAL VOCABULARY	sub-technical vocabulary load in Traditional Chinese Medicine texts	Hsu (2018)	RANGE software	Traditional Chinese Medicine English Word List (TCM EWL)
SUBTECHNICAL VOCABULARY	vocabulary of hard sciences from 12 sub-disciplines	Dang (2018a)	RANGE software	Academic Spoken Word List (ASWL)
SUBTECHNICAL VOCABULARY	vocabulary of soft sciences from 12 sub-disciplines	Dang (2018b)	RANGE software	Soft Science Spoken Word List (SSWL)
SUBTECHNICAL VOCABULARY	vocabulary in pharmacology texts	Heidari *et al.* (2020).	corpus analysis (Wordsmith software and AntWordProfile)	sub-technical vocabulary wordlist for Pharmacology PAWL of 750 word families

A tool that has been used for the identification of technical vocabulary in texts was the semantic rating scale. Specifically, it was used in the studies of Chung and Nation (2003; 2004) and Quero (2015; 2017) to assist researchers to identify the vocabulary of medical texts and classify it accordingly in different scales depending on the features of each word item (see Table 3). The semantic rating scale can be effective since it involves two researchers and often a subject specialist. However, it is a time consuming process when researchers compile large texts in their corpora. This was the realization that Quero (2017) reached when she used the semantic rating scale in large data for her medical texts analysis. This weakness can be eliminated with the use of corpus-based tools.

For the identification of both technical and sub-technical medical texts, corpus analysis tools have been utilized. Corpus analysis of medical texts involves a digital compilation and analysis with a corpus software, which provides rich linguistic information regarding specialised fields of expertise (Sanchez Ramos, 2020). In addition, the widespread usage of corpora in linguistic analysis is attributed to the high degree of effectiveness and sophistication they offer (Liu and Lei, 2020). This is due to the fact that corpora enable analysis of linguistic data simultaneously without manual intervention, which is word for word analysis (Coxhead, 2018). Thus, the use of corpora can save time and effort to the researcher, which could be the reason why this type of linguistic analysis was used more often in research, as seen in Table 7.

Corpus-based approaches allow the possibility to identify technical and sub-technical vocabulary in authentic data. As a computer software carries out the analysis, corpus studies can make it possible to observe the actual use of language in real contexts removing the possibility of perception bias or subjectivity from the part of the researcher. The benefit of this type of analysis is that it makes it possible to analyse large volumes of written texts in a short period of time making it possible to conduct research in a number of contexts. Due to the range of advantages that corpus analysis offers, it is the preferred method of identifying technical and sub-technical vocabulary in the written materials in the present study. The following sections aim to discuss a number of concepts related to corpora given that they have been utilised in the present study.

2.9.1 Word Form (Token) as a Way of Counting Words

Counting words can be administered in a number of ways; one way is through word families, which "may be morphologically distinct from one another [and] are, in fact, strongly enough related that they should be considered to represent a single lexical item." (Coxhead, 2000:217). An alternative to word families are word types "in cases where one of the word family members occurs frequently enough to be included in the analysis while other word family members are not. A word-type-based threshold can capture such a word whereas the word might be filtered out using a word-family-based threshold." (Ha and Hyland, 2017:16). Another way to measure words is through lemmas, which are "words with a common stem, related by inflection only, and related to the same part of speech" (Gardner and Davies, 2014:308).

However, the three proposed word measuring methods, e.g. word families, types and lemmas, had significant weaknesses when it comes to investigating word items that are derived, inflected or come from a different word class, such as the disciplinary vocabulary of medicine, which includes lexical items that are derived or inflected, further impacting their meaning and degree of technicality (Nation, 2016). This was further elaborated by Chung and Nation (2003) who mentioned that the caveat associated with studying the technical vocabulary of medicine and focusing on word families was that although some words in a word family might be technical, others might not. In addition, word types and lemmas are not suitable when the researcher is looking to investigate disciplinary vocabulary that is inflected, derived or it belongs to a different word class. Secondly, word families, lemmas and types may falsely give an impression that the learning effort is less on both the student and educator. Specifically, word families include words that carry specific core concepts within one word class and blend them with words from other word classes that carry different core meanings. This means that if learners lack the skills of decoding the word meanings of words from different word classes, it can be challenging to learn medical vocabulary by focusing, for instance, on word families alone. This is the reason why Dang (2018b) highlighted the fact that in order for word family lists to be effective learning tools, adequate knowledge of word processing skills is necessary.

An alternative way of counting words is tokens; the concept of tokens as a way of counting words correlates with the broad definition of what a word is, which is followed in the present study. Interestingly, Faerch et al. (1984) suggested that "A *word is a sequence of letters which is bounded on either side by space" (Faerch et al., 1984: 77). According to Faerch et al. (1984), in corpus linguistics tokens refer to the concept of word form. For instance, the following sentence has a total of 30 tokens: "in the bone marrow, a pluripotent stem can divide and form the red blood cells, platelets and a variety of white blood cells (leucocytes) that are found in the blood" (Naish et al., 2014:314). In addition, as Moghadam et al. (2012) correctly noted, "Tokens refer to the total number of words in a text or corpus" (2012:556). This means that derivatives, and inflected forms can be counted as different tokens. For instance, the following sub-technical words: phosphorylate, phosphorylates, phosphorylated, phosphorylating are four word forms/tokens. A token, or word form, as a unit of counting words, includes words as individual units regardless of base root, inflection or word class, which was necessary for the analysis of corpus data in this investigation. Therefore, for the purposes of the present study, word tokens were used for the analysis of textual data from the corpus for the generation of the receptive task and the lexical analysis of the productive task (see section 3.6.8 and Appendix ii). In addition, tokens can make it possible to avoid derivative filters, which might have led to unnecessary exclusion of technical words. While one of the limitations of word tokens lies on the fact that word tokens cannot identify differences in homographs (Narejo et al., 2016), setting the word-counting unit into tokens over other units such as lemmas, types or word families was, still, an advantageous decision. This is because they exclude derivatives and inflected forms from the analysis based on the assumption that students who are familiar with the basic form of a word would expand their knowledge and awareness of derivative and inflected forms (Dang et al., 2017). In addition, other aspects such as polysemy, which involves a qualitative investigation into word knowledge, multiword units (MWUs) and collocations may include more than one word in them and may, therefore, make it challenging to standardise the test and narrow its' focus.*

2.9.2 Word Frequency and Range

One feature of corpora analysis tools relates to the investigation of the degree of word frequency. Disciplinary fields employ a certain type of vocabulary and expression that appears frequently in them rather than in General English language. The concept of word frequency has been related to the hypothesis that the more frequently a word appears in a text, the more effective receptive word recognition can be (see section 2.5.2). For example, the more frequently readers *encounter a vocabulary item in a text, the more chances to recognise its written form. The reason for this lies in the fact that there seems to be a significant relationship between the frequency of appearance of a word item in a text and readers capacity to recognise it (De Groot et al., 2002). In addition, Gass (1988) pointed out that frequent encounters with a word could enhance reading fluency.*

Corpus-based studies aiming to investigate lexical items used in samples of a genre often tend to focus on measuring the lexical frequency as it has been claimed to reveal the kinds of words that learners encounters mostly along with collocates (McEnery and Wilson, 1996). In the area of medical texts analysis word frequency is a concept that has been studied in the work of Wang et al. (2008) who set a cut off point for word frequency of a minimum of 30 times as a criterion of sub-technical vocabulary identification. Although there are no clear rules for the cut off point for word frequency in a corpus, it is considered as an option for vocabulary selection particularly in studies aiming to generate vocabulary wordlists. For instance, Baker's (1988) cut off point was set to 300 times; Coxhead (2000) to 100 times, Wang et al. (2008) to 30 times, Hsu (2013) to 864 times, Hsu (2018) to 774 times, Gardner and Davies (2014) to 20%, which translated to 238 times and Lu and Durrant (2017) to 30 times. On the other hand, word frequency on its own may not be enough to observe unusual word items that occur frequently in a corpus (Ripamonti, 2015); therefore, a combination of word frequency with other corpus linguistics analysis measures, such as word range, can provide more valid findings.

The concept of word range relates to the outcome of an arithmetical calculation of lexical items proportion in texts. As early as 1921, Thorndike (1921) manually analysed a total of 4.6 million running words/tokens corpus and explained the concept of lexical range in simple words:

> *Range answers the question, how many of these forty-one different sources use the word? or how widely is the word used? (Thorndike, 1921: iii).*

Thorndike's final wordlist took into consideration word frequency, range and it consisted of a total of 10,000 tokens in English, which were suggested for learning and teaching purposes. A similar definition of the concept of range was provided by Baker (2004) who described the concept of word range as the numerical value that expresses the proportion of sources where a given lexical item can be found. In a *more recent study conducted by Egbert and Biber (2019), the concept of word range was reconceptualised as dispersion in texts. Specifically, they defined textual dispersion as a concept that "compares word use between the target and reference corpus in terms of the total number of texts where a word occurs at least once" (2019: 84). Based on the definitions of word range (dispersion) outlined above and in the context of the present study, word range expresses the proportion of texts where a lexical item is present within a corpus.*

Similarly, to word frequency, there is no set rule for cut off points on vocabulary range; therefore, different research studies proposed different cut off points. For instance, Coxhead (2000) set the range cut off to 4, and Wang et al (2008) and Hsu (2013) set the cut-off point to a minimum of 16, Hsu (2018) set it to 67, while Gardner and Davies set their cut off point to 7. By combining the features of word frequency and range, it can be possible to conduct a corpus comparison.

Thus, for the purposes of the present study corpus analysis has been utilized to conduct corpus comparison and identify the sub-technical and technical vocabulary in medical learning and teaching resources (LETERs) and design the receptive vocabulary task (see section 2.9.4). In addition, the same method has been utilised to conduct the productive vocabulary analysis aiming to identify the degree of technical and sub-technical vocabulary used in the participants productive tasks (see section 3.11.6).

Taken together, the advantages of word frequency and range can be combined in corpus-based studies. Yang (1986) suggested that corpora tools have the potential to conduct automatic identification of terms using a) word frequency and b) range (or word distribution) as parameters to be considered when extracting scientific lexical items:

> *there is a similarity not only in WHAT is used, but also in HOW OFTEN it is used. Here we have formed a straightforward hypothesis: since scientific/technical terms are sensitive to the subject matter, they should have fairly high frequencies of occurrence in texts where they occur but vary dramatically from one subject to another. It is therefore possible to identify scientific/technical terms solely on the basis of their statistical behaviour (Yang, 1986:96-97).*

In the same vein, studies such as Chung and Nation (2004), Hsu (2013), Quero (2015), Ripamonti (2015), Quero (2017) and Dang (2018a; 2018b) may be of great interest in the area of lexical analysis of EMP. This is because they utilised the corpus analysis software, RANGE, which is freely available and can process a corpus instantly providing accurate results with regard to both frequency and range. The significance of the use of RANGE (Heatley, Nation and Coxhead, 2002) lies on the fact that it can process authentic language data and conduct corpus comparisons bringing instant and reliable findings that can be replicated within one specific or other disciplinary contexts (Chung and Nation, 2004). Bearing in mind these advantages, it was this software that the present study relied upon in order to examine density and receptive vocabulary task development (see sections 3.5 and 3.6.3).

2.9.3 Lexical Coverage

The concept of lexical coverage is associated with the degree of familiar vocabulary needed to facilitate understanding of discourse. . Specifically, It is measured by means of estimating the percentage (%) of known minus the percentage of unknown words in a given text. It specifically refers to "the degree to which words in input are known by readers and listeners. For example, if a text consists of 100 running words and five of those words are unknown, lexical coverage of that text would be 95%" (Webb, 2021:278). Webb's (2001) definition of lexical coverage encapsulates its' conceptualization in the context of the present study, specifically, lexical coverage expresses the proportion of vocabulary items that are known by medical students when they read a disciplinary text. Lexical coverage is calculated as the percentage proportion of familiar words in relation to unfamiliar ones in a given discourse. Schmitt et al. (2017) suggested that lexical coverage could be estimated by means of looking at "what percentage of the vocabulary in a stretch of spoken or written discourse needs to be known by a learner in order for him or her to understand the discourse." (Schmitt et al., 2017:213). Webb (2021) detailed how lexical coverage is measured in practice rather eloquently as seen below.

"there are usually around 14 words in a line of typed text and 400 running words on a page. At 95% lexical coverage, one out of every 20 words is unknown, which means that there are about two unknown words in every three lines on a page, and about 20 unknown words per page. At 98% lexical coverage, one out of every 50

words is unknown, which means that there is about one unknown word every 3.5 lines and eight unknown words per page. Considering the amount of effort that would go into understanding 20 pages of written text and the 400 encounters with unfamiliar words at 95% coverage, lexical coverage figures of at least 95% for reading comprehension make sense." (Webb, 2021: 278-279). It is clear from the above that lexical coverage is indicative of the degree of the amount of cognitive work, or the "comprehension demands" (Harrington, 2018:21), that students have in order to understand a given text. As discussed in the previous section 2.9.2, the more frequently a word item is used in a text, the higher the odds for readers to be familiar with it. While word frequency is indicative of which words one should expect readers to be familiar with, lexical coverage aims to demonstrate the percentage of words likely to be familiar or unfamiliar to the reader. Therefore, the relationship between lexical frequency and lexical coverage is a relative one since the more frequent words would cover the lower levels of lexical coverage and infrequent word items can lead to higher degrees of lexical coverage.

The concept of lexical coverage is an abstract one and it was introduced in order to suggest how lexically demanding a text is. Interestingly, Harrington (2018) described textual coverage as a "benchmark" (2018:34) for receptive knowledge in that the higher the percentage of text coverage, the higher the degree of reading comprehension or fluency. Lexical coverage can be an assumed estimation of learners' degree of receptive recognition with words in English based on a percentage. In corpora analysis, the percentage of lexical coverage can be indicative of the lexical burden (see section 2.4) that a text is loaded with and it can provide an estimation of the lexical demands. For instance, Hsu (2013; 2018) found that General English vocabulary had a high coverage in medical textbooks (70.68% of the tokens). This suggests that a considerable proportion of lexical items that cover 29.32% of the total words included in the corpus is beyond that level and impact students with a lack of knowledge of vocabulary beyond General English. The researcher translated it as "one unknown word in every three to four words being read" (Hsu, 2018: 104). Thus, the researcher utilized lexical coverage to investigate the sub-technical vocabulary, which typically ranges higher than General English vocabulary. It appears from the above that lexical coverage allows researchers and educators to assess discourse in terms of its' lexical demand on learners. However, in the case of a 100% lexical coverage, it does not necessarily guarantee that a *reader has fully comprehended the words in a given text (Hu and Nation, 2000; Schmitt et al., 2011).*

Different percentages of lexical coverage have been suggested for sufficient understanding of a text. For example, 95% of lexical coverage was suggested for basic grasp of a text (Laufer, 1989; Laufer and Ravenhorst-Kalovski, 2010, van Zeeland and Schmitt, 2012). This essentially means that learners are expected to have one unfamiliar word per two lines of text (Schmitt et al., 2017:214). However, other researchers found 95% of lexical coverage to be insufficient in order to understand a text. Hu and Nation (2000) provided further evidence on the ideal percentage of lexical coverage. The researchers examined the degree of unknown words in texts in relation to participants' comprehensiveness by means of testing them on 80%, 90%, 95% and 98% of lexical coverage for achieving substantial understanding. Results suggested that when participants were tested on the 98% level of lexical coverage, they showed signs of adequate understanding of a text in English. Therefore, the 98% degree of lexical coverage was considered as optimal for sufficient understanding as proposed by Hu and Nation (2000) and further supported by Nation (2001; 2006), Laufer and Ravenhorst-Kalovski (2010) and Schmitt et al. (2011). According to Nation (2006) and Hsu (2018), the ideal percentage of lexical coverage specifically for receptive vocabulary reading fluency was 98%, which is translated as one unknown word in every 50 words. However probabilistic this approach to vocabulary may appear to be, these two percentages for lexical coverage have been suggested by scholars as a means to determine a threshold for measuring learning materials (Laufer and Ravenhorst-Kalovski, 2010; Quero, 2017).

Two target percentages of lexical coverage were suggested for sufficient understanding of a reading text but the ideal percentage is still debatable. For instance, Harrington (2018) suggested the 98%-99% of text coverage threshold as ideal in order to generate assumptions on fluent and effortless reading of texts. It seems that the various lexical coverage percentages were proposed in an effort to suggest satisfactory understanding of vocabulary in a given discourse. In addition, Laufer and Ravenhorst-Kalovski (2010), commented that the goal of 100% lexical coverage may not be feasible, yet 98% of lexical coverage may be considered as adequate with 95% set as the minimum level of understanding of the vocabulary in a given text. This means that 95% of lexical coverage indicates that a learner may *be able to develop a general understanding of a text with the additional use of other resources such as a dictionary. On the other hand, a 98% lexical coverage indicates "an optimal lexical threshold" (Quero, 2017: 178). Thus, a number of lexical coverage percentages were discussed in the issue of lexical coverage. For the purposes of the present study, the idea of optimal vocabulary knowledge was redundant due to the fact that it lacks specificity and consistency. Thus, the percentage of 95% discussed in this section, which suggests a threshold of basic understanding of a text (Laufer, 1989; Laufer and Ravenhorst-Kalovski, 2010, van Zeeland and Schmitt, 2013) and the 99% of lexical coverage indicating effortless and fluent reading (Harrington, 2018) were considered in this study.*

As can be seen, lexical coverage is an indispensable tool for assessing the lexical demand of written texts. One reason for this relates to its strong link with vocabulary size (van Zeeland and Schmitt, 2012). Specifically, the concept of lexical coverage was predominantly utilized as a means of evaluation of suitable vocabulary included in texts based on students' current level of competence, thus, making it possible to facilitate incidental learning (van Zeeland and Schmitt, 2013). In addition, lexical coverage is a related concept to textual sophistication and density, as discussed in section 2.9.5. In the context of the present study, lexical coverage analysis was an important step towards the development of the Receptive Recognition (RecRec) task. Specifically, the Learning and Teaching Resources (LETERs) materials, which were analysed in terms of lexical coverage, were recommended by medical expert instructors in the faculty where the present study took place with a view to cover medical students' needs for scientific knowledge without prioritizing their lexical load (see sections 3.3 and 3.4). Designing a task based on balanced and representative vocabulary that covers different percentages of lexical coverage in LETERs texts was necessary in order to examine to what extent medical students were familiar with vocabulary belonging to different degrees of lexical coverage from their first week of medical studies until the end of their initial semester. The rationale of the present thesis was to reverse the principle of lexical coverage from its current capacity to assess students' textual data in LETERs to the design of an assessment tool aiming to measure participants' vocabulary size by evaluating the degree of receptive recognition of vocabulary that belongs to different degrees of lexical coverage in LETERs. To this end, the lexical coverage output that emerges from the RANGE program was utilized, as a resource for the target vocabulary of the RecRec task and lexical coverage percentages were used as *a framework based on which different degrees of lexical coverage would be represented on the receptive task (see section 3.6.6). In the context of the present study it is interesting to mention Coxhead's (2018) hypothesis that lexical coverage is indicative of "how many words are needed to understand a text" (2018: 21). Based on the reverse principle of lexical coverage discussed in this section the lexical coverage hypothesis on the Receptive Recognition (RecRec) task design can be redefined as: the RecRec task is suggestive of how many words representative of lexical coverage are effectively received (recognized) at a given point in time.*

2.9.4 The Mirror Corpus

In corpus analysis research, the use of a mirror corpus is associated with a number of advantages. According to Coxhead (2018), a mirror corpus can be useful in order to validate a newly compiled corpus by means of observing variations in tokens usage as well as checking for lexical coverage. In the present study, two types of corpora will be examined. Specifically, the "general and specialised corpora" (Brezina and Gablasova, 2018:609) will be mirrored. The former refers to a collection of casual/everyday use of English from a variety of individuals and contexts, while the latter refers to corpora texts derived from a speech community in specialised contexts, such as medicine, nursing, dentistry, to name a few. In the present study, both of these types of corpora will be used. Specifically, the medical corpus will be considered as the specialised, while certain wordlists of the BNC would be classified as General and investigate areas of overlap in line with Chung and Nation (2003). Standardised corpora such as the Corpus of Contemporary American English (COCA) (Davies, 2020) and the British National Corpus (BNC) can be used as mirror corpus. This was justified by Dang (2019) who claimed that "The BNC/COCA lists are the largest and most recent and popular frequency-based wordlists of general English." (2019:447). Although the COCA is a high quality corpus, it was the BNC that was selected as the mirror corpus for the purposes of the present study owing to the fact that the language variety that the present study is looking at is British English.

In addition, the BNC can compare texts, analyse, mirror the everyday language, and highlight the odd, specialised vocabulary without necessarily looking for an expert opinion. It is a reality that language has changed since the 1990's, when the BNC was created, especially the language of everyday conversations. However, the *language of disciplinary expression tends to be the same and what usually changes is the neologisms/coining of new terms. Therefore, while the standard vocabulary of medicine might not change some of the everyday conversation vocabulary might change as societies change. For instance, some terms that belong to the medical discipline might gain popularity through raising public awareness leading to their incorporation in daily discourse. To illustrate this, the BNC of the 1990's might have not included medical terms such as depression/depressed/anxiety as it would at the time of the present thesis writing due to the attention placed on mental health. The implication for this relates to the fact that identifying automatically these terms that are part of discourse nowadays would not be possible and instead they would be classified as medical terms only. This is not necessarily a disadvantage irrespective of frequency change and addition to everyday discourse, these words are still medical terms that happened to be broadly discussed. This reality suggests that if the BNC did not notice some of these terms, it would class them as technical or sub-technical vocabulary and they might be already known to subjects due to the fact that they are currently used more frequently in lay discourse compared to the past. This might lead to less accurate findings with the technical and sub-technical receptive task being too easy for medical students to take. Given that the present study looks at vocabulary that represents 60%-99% of lexical coverage of the LETERs it can be understood that vocabulary between this percentage range is more typical of the medical field and as the percentages escalate up to 99% of lexical coverage, the vocabulary becomes more and more specialised. In that case whether an older version of the BNC should not necessarily be a disadvantage given the fact that the medical terns assigned for specific concepts/process tend not to change in the manner that everyday language changes. Taken the above into consideration, the BNC's ability to identify technical vocabulary in corpora automatically is still compelling.*

Specifically, the BNC is a reliable mirror corpus due to the fact that it is designed following high standards. Specifically, for its' compilation, authentic lexical data from a variety of contexts totalling 100-million running words were collected. Spoken data comprise 10%, while written texts comprise 90% of the corpus (Leech et al., 2001) of the BNC corpus. Upon analysing the BNC data in terms of word types and lemmas in terms of frequency, text coverage and range, lexical data from the BNC were utilised by Nation (2006) in line with the principles that generated the GSL to produce the 25 BNC lists of headwords (BNC1-BNC25). Each of the 25 lists of *headwords documented word items in the form of word families, thus, previous knowledge of the base word of lexical items is likely to facilitate learning of its derivatives (Nation, 2001). In addition, the developing students' awareness of base words (i.e. word families) can increase vocabulary size as learners may recognize a prefix or a suffix and make up a new word (Nation (2001). Taken this into consideration, it has been claimed that awareness of word families can assist learners' mental associations between different word items and lead to more effective learning (Jones et al., 2016). Lately, the BNC1-BNC25 headwords can be used to "find out more about the nature of the lexis in written and spoken texts" (Coxhead, 2018:40). Thus, a corpus comparison with the BNC25 headwords as a mirror corpus can shed more light on the degree of complexity of reading texts. Although there is no set rule as regards to vocabulary classification, an example of the BNC mirror corpus data output was considered: High Frequency vocabulary (BNC1- BNC2), Mid-Frequency vocabulary (BNC3-BNC9) and Low-Frequency vocabulary (BNC10-off-list) (Horst, 2013; Schmitt and Schmitt, 2014; Douglas, 2015). In addition, the semantic rating scale was not implemented along the use of mirror corpora due to the additional labour involves in large corpora such as the ones utilised in the present study (Quero, 2015; 2017). Therefore, a mirror corpus (BNC) was selected for the purposes of the present study and the way that it was handled suit the purposes of the present study as documented in section 3.6.4.*

2.9.5 Lexical Density

Lexical density is an aspect of measuring textual intricacy and richness in discourse. As a concept, it was first defined by Ure (1971) as the proportion of content words to the entire sum of words in a text and Haliday (1985) associated it with "the kind of complexity that is typical of written language" (1985, p. 62). Halliday (1989) associated it with the written discourse and found that higher lexical density seems to be a typical feature of academic discourse (Biber, 2006). A follow-up definition of lexical density was provided by Halliday and Martin (1993), who provided a more insightful view of lexical density from the perspective of how dense vocabulary items in a discourse are, in a grammatically structured text. In addition, Johansson (2008) associated lexical density with the concentration of information in discourse and generated the assumption that the higher degrees of lexical density in a discourse, the more loaded in terms of concentrated knowledge it is. More recently, Lee (2019) associated lexical density with the amount of nouns *used in texts as they normally carry information; by investigating the amount of nouns used in L2 students' productive discourse the researcher found that extensive use of nouns were indicative of a wider mental lexicon. Recently, Nasseri and Thompson (2021) suggested that lexical density explores vocabulary items that appear in sentences and the extent to which they are dense.*

Parallel concepts to lexical density are lexical sophistication and lexical diversity, which altogether form the analysis of lexical richness. Unlike lexical sophistication, which examines only the low frequency vocabulary in discourse (Laufer and Nation, 1995) and lexical diversity, which looks into the degree of variability of word types, lexical density explores vocabulary items that appear in sentences and the degree of textual complexity in them (Nasseri and Thompson, 2021). Specifically, it aids the understanding of "how densely lexical items are packed into syntactic structures" (2021:1). Moreover, lexical density is associated with "the kind of complexity that is typical of written language" Halliday (1985, p. 62). It is a statistical calculation of the degree of richness of discourse as a means to examine students' achievement (Daller et al., 2003).

It can be estimated by means of measuring the amount of lexical items against the total number of tokens in a given text (Ure, 1971; Biber, 2006; Pietilla, 2015; Biber and Gray, 2016). Ure (1971) suggested that the operationalisation of lexical density analysis estimates the proportion of the number of content words to the number of words/tokens. It can be calculated based on the sum of the target vocabulary against the total number of running words in a given text (Halliday, 1985; Biber, 2006; Biber and Gray, 2016, Pietilla, 2015). The operationalisation of lexical density in the past used to involve actual researchers who would manually examine the vocabulary included within texts. In addition, Dor'o and Pietil'a (2015) found that there were no significant differences in the lexical density calculation between human raters and the implementation of corpus analysis software. Lately, the operationalisation of lexical density analysis can be automatized through corpus compilation (Nasseri and Thompson, 2021).

Early studies in the field by Halliday (1985) suggested that lexical density is "the kind of [vocabulary] complexity that is typical of written language" (1985:62). Moreover, Kim (2014) found that lexical density can be indicative of writing proficiency and future linguistic achievement (Gonzalez, 2013; Mazgutova and

Kormos, 2015; Yoon, 2017). In a comparative study conducted on L1 and L2 learner differences on lexical density involved samples from concluding MA thesis sections by Pietila (2015). The researcher suggested that L2 writings were less dense than L1 writings. In addition, the presence of nouns in discourse was linked with rich ideas in writing (Pietila, 2015). Moreover, lexical density has been associated with writing proficiency (2014) and was claimed to be indicative of future linguistic achievement (Gonzalez, 2013; Kim, 2014; Mazgutova and Kormos, 2015; Yoon, 2017). Lexical density relies on the study of tokens, unlike lexical diversity, which involves the study of word types in a text (Yoon, 2017). Halliday (1985) advocated that a typical feature of written discourse is its' "lexical density" (1985:61) in the written medium. Specifically, he advocated that lexical density in written texts might be higher than the oral density as a means to examine students' achievement (Daller et al., 2003).

Lexical density forms part of the measurements for the lexical richness of written texts especially within the context of academia and it provides insights as regards to the load of information included in discourse (Kouachi, 2021 Biber and Gray, 2016; Biber, 2006, 2016). It can be argued that lexical density is a meaningful parameter to consider in textual analysis as it can provide further insights with regard to the degree of complexity of texts that medical students encounter during their initial semester of medical studies.

2.10 Summary and Conclusion

This chapter aimed to discuss key ideas and concepts that are related to the present thesis. Specifically, two types of medical vocabulary have been discussed in this chapter: the technical vocabulary, which is limited only in medicine and the sub-technical vocabulary, which is shared amongst a variety of academic disciplines. Both types of vocabulary play a key role in medical discourse and are examined in the present thesis due to the fact that they have idiosyncratic features that make it particularly challenging for new medical students to acquire; for instance, its etymology.

A review of studies in the field reported in this chapter aimed to contextualize the present research study in the field of English for Medical Purposes EMP in line with concepts associated with corpora analysis such as word frequency, range and *lexical coverage. In addition, a review of what it means to know a word is provided along with a discussion on what receptive knowledge involves in line with a reference to one of the basic types of receptive knowledge, which is the receptive recognition. Since recognition of word form (spelling) emerges as the first type of word knowledge individuals learn, it can be utilized for the purposes of the present research to measure alterations on vocabulary size of technical and sub-technical lexical items appearing in medicine. In addition, productive usage of technical and sub-technical vocabulary can be investigated as will be discussed in the following chapter.*

In sum, this chapter explained a number of concepts that the present study relies on in order to answer its research questions and contextualize the present study. In addition, the role of learning and teaching materials play in medical students' incidental and deliberate learning of new vocabulary was discussed and as was seen in the review of related studies to date, such resources were mostly utilized in order to generate disciplinary wordlists. Thus, it becomes evident that research in corpora is necessary in order to gain a better understanding of the vocabulary in the field, contextualize and contribute in the field of EMP. Interestingly, there is more to learn from data from actual first year students who study medicine and come face to face with medical vocabulary on a day-to-day basis. The ways in which this has been achieved are going to be discussed in the following chapter.

Chapter 3 Methodology

3.1 Introduction

This chapter introduces and explains the methodological aspects that were considered for the purposes of answering the research questions that the present study is focused. The methodology implemented in the present study combines corpus compilation and analysis, elements of corpus statistics, corpus profiling and test design based on raw language data aiming to gain databased insights on the receptive and productive type of vocabulary. In addition, further information is included regarding the research background, subjects' demographics and ethical considerations in place.

3.1.1 Research Questions

The key focus of the present study relates to the investigation of first year medical students' receptive and productive technical and sub-technical vocabulary. By collecting evidence-based data it can be possible to fill in a gap in the literature of EMP which involves new medical students' in UK institutions and their capacity for receptive and productive use of two types of disciplinary vocabulary, the technical and sub-technical, to answer the research questions outlined in section 1.4.

The first research question looks into the type of vocabulary, which medical students encounter during their independent study of the Learning and Teaching Resources (LETERs). The second research question aims to assess medical students' receptive recognition of the vocabulary they were introduced to in their LETERs at the beginning and end of their initial semester of studies. The third research question looks into the amount of technical and sub-technical vocabulary that medical students are capable of producing in writing and the fourth question looks into differences in receptive and productive vocabulary between L1 and L2 subjects. In order to answer the research questions that the present thesis intends to explore, a combination of corpora compilation, analysis and test design were utilised as discussed in the sections that follow.

3.2 The Medical Receptive (MEDREC) Corpus Compilation

The discussion of this section as well as sections 3.2.1 to 3.5.1 aim to provide methodological perspectives with regard to the first research question (see section 1.4). This section aims to introduce the Medical Receptive Corpus, which included LETERs and, from now on, it will be referred as MEDREC. The MEDREC corpus designed for the present study is a result of bringing together theories of language discussed in section 2.2.1 such as deliberate and incidental learning. Incidental and intentional learning hold a similar position, which suggests that the possibility to learn vocabulary increases depending on how many times one is exposed to it incidentally or deliberately (Webb and Nation, 2017). Thus, creating incidental and deliberate opportunities to encounter it can enhance effectiveness (Nation, 2020), for further discussion see section 2.2.1. Given that the present study does not aim to teach but rather examine what opportunities for incidental vocabulary were offered to medical students during their initial semester of studies from LETERs, the usage of corpora compilation was necessary to help quantify findings. Thus, the corpus that can be generated from this study can be considered as an interdisciplinary one. This goes in line with Canziani et al. (2014) stipulation that interdisciplinary studies necessitate collaboration between linguists and subject specialists. In the context of the present study, this has been achieved by means of contacting medical instructors and the medical faculty. Permission to acquire first year medical students' essential textbooks reading list and learning and teaching materials was requested. In this way, the MEDREC was designed based on selection of authentic materials for the Textbook Sub-corpus (TS) and resources accessed only from the internet were compiled on the Online Resources Sub-corpus (ORS) leading to data focused on specific learning demands not randomly but based on needs analysis (Jablonkai, 2020).

Thus far, medical corpora specifically for first year medical students were compiled only in the study of Quero (2015) which, similarly to the present study, focused on compiling a textbooks corpus in order to assess the volume of technical vocabulary included in it. The main aim of Quero (2015) was to evaluate the learning burden based on technical vocabulary presence in textbooks and generate a wordlist. However, the reality is that medical students rely not only on textbooks but also on other resources for their study such as the lecturers' slides and faculty materials. This fact was considered during the MEDREC compilation to *include as many materials used by medical students as possible following a more holistic approach towards medical students' resource materials usage. To this end, the Textbook Sub-corpus (TS) and the Online Resources Sub-corpus (ORS) was generated. It should be mentioned here that all members of staff involved in the course gave their permission to use the resources included in the MEDREC, which were available to first year medical students for the purposes of the present research study.*

The six resources included in the TS and ORS of the MEDREC discussed here were available to first year students of medicine. The textbook resources were compiled in the Textbook Sub-corpus (TS) and together with the Online Resources (ORS), they were compiled in the MEDREC corpus (see section 3.3, 3.4). The type of vocabulary included in them is discussed in sections 4.2.1.1 and 4.2.1.2. The process of selection of text samples from each resource for the generation of the MEDREC corpus is described in the sections that follow (sections 3.3 and 3.4).

3.2.1 Significance of the MEDREC Corpus

The MEDREC corpus is significant for the purposes of the present study given that it is based on up-to-date, varied and accurate lexical data. Specifically, the MEDREC corpus is diverse and it is designed in order to contribute to the analysis of the present study based on a large compilation of five full sized medical resources and 36 sampled medical textbooks included in it (see section 3.3.2). Although Atkinson et al. (1992) suggested an equal length amongst corpora resources as ideal in corpus analysis research, in the present study numerous sources of data were involved each of which with different length aiming to examine the entirety of vocabulary intake over the period of one academic semester of studies. Excluding them would be limiting the sample size and result in significant loss of important data, making it impossible to investigate the majority of texts that medical students encounter in their readings. Significant attention was given to collect as much language data samples as possible because exclusion of data might distort the findings of the kind of vocabulary that medical students encounter during their initial semester and further impact on the follow-up RecRec task (see section 3.6). In order to overcome the potential inaccuracies that such decision might bring, corpus output data were converted into percentage decimals to facilitate understanding and data comparisons, as seen in *section 4.2. Thus, authenticity, diversity and full texts compilation from as many resources as possible were the main features that attribute MEDREC a high quality standard in terms of utility and validity in the present study.*

As mentioned previously in section 3.2, the MEDREC corpus was intended to be used as the foundation for the design of the word recognition (RecRec) task that examined students' development of vocabulary recognition over their first semester of medical studies. Medical students' involvement with the sources compiled on the MEDREC, as reported on the Ranking Task (see section 4.2.3), confirmed usage of the resources of the MEDREC, thus, enhancing the reliability and validity of the RecRec, which was based on the MEDREC language data compilation (section 3.6.8). An additional confirmation questionnaire showed that medical students indeed read a significant number of texts compiled on the MEDREC (for further discussion, see section 3.5.1). The confirmation of usage of the LETERs included in the MEDREC makes it possible to assume that the majority of resources compiled and further analysed on the MEDREC corpus were used to facilitate medical students' independent learning of medical information. This means that the vocabulary included in the RecRec task was indeed encountered by medical students during their initial semester of studies. Thus, it was part of the utility of MEDREC to collect language data in order to facilitate the design of the RecRec Task.

In addition, the MEDREC represents authentic medical discourse intended towards students on their first year of medical studies. This resource is considered as a more preferable one compared to specialized dictionaries (Nation et al., 2016), which address a generic population of medical specialists from a variety of contexts, levels and degree(s) of specialization. In the present thesis, the use of a dictionary was considered as time consuming due to the size of the corpus and time pressure to produce the RecRec task. Instead, the corpus comparison could compensate for the lack of use of a medical dictionary since the MEDREC corpus relied on up-to-date authentic language data from Learning and Teaching Resources (LETERs). The present study followed the doctrines suggested by Nation et al. (2016) for the generation of wordlists from a textual corpus since it relied on texts recommended by specialists in the field. In addition, it utilised the BNC as a comparison corpus (see section 2.9.4) and it also included texts from visuals such as images and diagrams (see sections 3.3.1). The MEDREC corpus was then *classified into 40 sub-lists and each sub-list was then compared with a mirror corpus, in which case, the British National Corpus (BNC). A similar practice was shown to be effective for the distinction between technical and sub-technical vocabulary (Hsu, 2013; 2018) (see section 2.9.1). Thus, the MEDREC provided authentic input towards the generation of a receptive recognition task.*

3.3 The Textbook Sub-corpus (TS) Generation

This section aims to discuss the generation process of the sub-corpus that is part of the MEDREC corpus, the Textbooks Sub-corpus (TS). The TS is based on first year medical students' faculty recommended bibliography list of 36 medical textbooks to provide a more in-depth knowledge of topics discussed in the lectures such as pathology and microbiology as well as social and legal approaches to medicine. Medical textbooks belong to the academic genre; specifically, they are descriptive and analytical and included up-to-date medical knowledge at the time of the research. They were organised in chapters that focused on one specific theme each and discourse relied heavily on visuals such as diagrams and images. Medical textbooks were not used during lectures; instead, they were intended to be utilized for independent study in order to consolidate and expand on medical students' understanding of the topics discussed during lectures. The medical textbooks included in the present study were part of a suggested reading list from the instructors to the students with recommended textbooks for first year students to suffice their understanding and expand on their knowledge of a wide range of topics.

3.3.1 The Digitization Process

The digitization process relates to the steps taken in order to digitize hardcopy medical textbooks that form part of the TS. A typical feature of medical textbooks relates to the size of their hardcopy version with thousands of pages included in each volume. While currently, there is a wider availability of online downloadable textbook versions that before, ultrafast scanners and apps that can minimize the amount of time spent digitizing documents. A fully downloadable textbook version in pdf or .docx format would be ideal for the purposes of the present study, as it would ensure fast and accurate digitization. However, at the time of textual data collection, many of the medical textbooks were available only in hard copy version *and not in digital form. In addition, there was no financial support provided in order to gain access to the textbooks' digital version. Thus, it became necessary to collect textbook data by employing the use of a digital scanner. Because each scanned file could not be directly converted into .txt file, which was the only version that the corpus analysis software was compatible with, each scanned page was converted from .IMG to .JPG file format. Because the available technology at the time of the research did not allow the researcher to convert a .JPG file directly into .txt format, each scanned .JPG page was converted into a .PDF file. Then, the new .PDF file had its format changed and saved as a .docx file through the Adobe Acrobat OCR feature. Finally, the .docx file had its format adapted into .txt. This series of format conversions was repeated for each page for more than 2-million textbook pages in order to collect sufficient data to develop the TS.*

In addition, a decision was made to include the text appearing in images, tables and diagrams into the TS. This is because the vocabulary included in images and diagrams was often summarising important components of medical information or reflecting upon key medical knowledge. In addition, visuals are common in medical education resources and can lead to effective quality of learning (Sahiti and Stamp, 2021). In studies that examined the vocabulary in medical texts such as Hsu (2013; 2018), all images and diagrams were excluded without acknowledging the educational role of key vocabulary included in the visuals. However, in this study, an additional effort was made to manually type in the text appearing on all visuals. By doing so, it was possible to include a larger amount of input that medical students encountered in the form of key vocabulary included in visual information.

In addition, each scanned textbook page underwent a process of manual edition due to scanning errors. Frequent scanning errors involving misspelt word items were also reported by Fraser et al. (2016) who commented that their corpus was in need of manual editing. In addition, Nation (2016) highlighted the importance of correcting the corpus text from spelling or punctuation errors prior to running a corpus analysis to generate vocabulary lists. Therefore, the researcher manually edited the word spelling of all errors appearing on scanned pages from medical textbooks included in the TS. Errors such as spe? Cific for specific, par t for part, becaus e for because, control? ing for controlling and intracellu lar for *intracellular (for instance, see Appendix D and E) were as frequent as at least one in almost every line of the TS and if left unedited, they would lead to erroneous corpus output and limited reliability.*

Moreover, all abbreviations and hyphenated forms were eliminated from the TS. Although they appear frequently in the medical genre, they are not in line with the aims of the present study, which focuses on single word items/tokens list. In addition, it was impossible to process them in the corpus analysis software that was utilized at the time of the present research. Thus, all punctuation marks were eliminated and this applied to the elimination of hyphens (-) in line with Dang and Webb (2014). Nation (2016) considers that the elimination of hyphens in a corpus depends on the researchers' choices and on the kinds of words investigated in the corpus. A similar process was also followed by Hsu (2013; 2018), who also eliminated hyphens from her corpus for similar reasons. Therefore, compound words such as: cross-feed, single-cell, well-defined, blood-forming that were found in the TS were converted into: cross, feed, single, cell, well, defined, blood and forming.

Furthermore, another important aspect for the development of the TS relates to the exclusion of referencing sections and abbreviations. Specifically, references would include authors' names, titles and publishing houses and have an important place in textbooks list of references as they indicate good conduct of research and textbook writing skills. The elimination of referencing sections was necessary as they would inadvertently interfere with the total number of running words in the corpus in line with similar studies such as Chen and Ge (2007), Wang et al. (2008) and Hsu (2013; 2018). In addition, other textual elements that would possibly create problems in the running of the corpus software leading to inaccurate findings were eliminated (Hsu, 2013; 2018), such as letter abbreviations e.g. HLDH, ATP, COPD, IVP, CRs. This is because abbreviated forms represent but do not constitute words by themselves and they usually refer to full word forms. Since the present study is looking at full word forms, abbreviations were eliminated from the corpus.

3.3.2 The Textbooks Sub-corpus (TS) Sampling

Sampling process involved the selection of sample data from medical textbooks. Given that the selection of textbook samples should reflect the vocabulary *included in other chapters of the medical textbook in order to enhance reliability, a pilot study was conducted. The decision for the pilot study was supported on the ground that at the time of textbooks sample collection there was no published study on medical textbooks density of most of the vocabulary. Because of this lack of awareness randomised textbooks sample collection was the case for the present study and would increase the validity of this study. Therefore, a lexical correlations study on pilot level was conducted by the researcher and is reported on Appendix B. Based on findings from the pilot study, which involved the correlated vocabulary between introductory chapters and various different chapter texts, it was possible to observe which sections provided higher concentrations of vocabulary items. The Pilot Corpus consisted of 428,486 running words and it was compiled prior to the commencement of the TS data collection in order to test and verify the hypothesis that introductory chapters reflect the follow-up vocabulary expression in other chapters of the same textbook. The key finding from the pilot study was that the introductory and initial chapters of medical textbooks do reflect the vocabulary usage of other chapters included in the four sampled medical textbooks.*

Bearing in mind the findings from the pilot study, introductory and beginning chapters from medical textbooks were included in the Textbook Sub-corpus (TS). In addition, a copy limit of 9% was observed to represent books of various types and sizes efficiently. Although this percentage might sound small, it should be noted that from the medical textbook sources where data was collected a minimum of 200 and a maximum of 2,000 pages were sampled. This allowed the researcher to select sufficient textbook samples from each suggested textbook resource for the purposes of the present study. Therefore, a balanced sample of textbook materials was selected for the purposes of the present study. Ultimately, the introductory pages from a total number of 36 textbooks out of the 41 suggested bibliography textbooks for year 1 students were selected for the generation of the TS reaching a total number of 927,546 running words (to access the suggested bibliography, see Appendix C).

3.4 The Online Resources Sub-corpus (ORS)

The Online Resources Sub-corpus (ORS) compiled textual data that were available to participating subjects in online form via the Blackboard platform. In addition, a *number of online resources was made available to medical students on a secure website that they were given access to via their faculty.*

3.4.1 The Pathology Interactive Practicals (PiPs)

A source of input for the ORS was the online Pathology Interactive Practicals (PiPs). This resource is part of the academic genre and included descriptive and analytical components in it as well as critical questions, which made it interactive. Specifically, subjects were shown pictures or clips of body parts, microorganisms or infectious diseases. Then, they were asked to answer multiple-choice questions. Feedback for both correct and incorrect answers was provided to students in the form of a positive or negative reinforcement followed by related explanations and justifications (as seen on Appendix G). The PiPs were divided into different sections following the topics discussed in each pathology lecture. In addition, the text genre from the PiPs, although interactive, was intended to be used in digital form with each student working through PiPs on his/her own in order to prepare for their pathology lectures. Through the images and interactive questions-answers, students would gain a glimpse of the concepts that were discussed during pathology lectures. The PiPs materials were authored by faculty members of staff and their content was linked with pathology lectures or tutorials that medical students attended during their initial semester of studies. Participating subjects were recommended to visit the interactive page of PIPs prior to their pathology lectures as a warm up.

The PiPs materials were particularly challenging to collect due to their copyright format settings. Although permission was granted, a new challenge arose as a result of the University's copyright protection of the PiPs, which made it impossible to download, select, or copy-paste the texts included in them at the time of the research. Due to the lack of availability of the PiPs texts in .txt form, the following process of language data collection from PiPs was utilised in order to deal with this issue. Texts appearing on the computer screen were captured and pasted onto an empty word file. Each printed screen was then converted into a .PDF file in order to extract the characters appearing in it. Then, the OCR feature was activated, as described in section 3.3.1. Specifically, each document was converted into a PDF and from a .PDF file; the OCR feature would recognize the characters appearing in it and store the information into a word file (.docx), *which was then converted into a .txt file, which is the format that the corpus analysis software was compatible with at the time of this study. Similarly, to the TS generation (see section 3.3.1), all abbreviations, hyphens and punctuation marks were eliminated and the vocabulary appearing in pictures, diagrams or misspelt words was manually edited. A total of 42 PiP files were converted into .txt files and language data from the PiPs resulted in 71,966 running words (see Table 8).*

3.4.2 Lecture Slides

Another source of data for this study was the collection of lecture slides (.pptx files) in digital form (see Appendix I). The genre of the lecture slides compiled in the ORS was written academic texts. Lecture slides supplemented oral delivery of sessions in medicine and students were introduced to their visual mode in lecture rooms followed by discussions and elaborations from their medical instructors. Therefore, lecture slides included key ideas of each session, which were further explained by lecturers and students were given the opportunity to ask further questions after the end of each lecture. Thus, it seems that the lecture slides genre combines both written and oral communication. However, the focus of the present study was mainly on the written medium given that it looks at the written form of words. The style and expression of PowerPoint presentations was often brief and concise presenting new information in bullet point form and, depending on the kind of information included in them, there was a variety of lexical structures such as complete sentences, phrases or single word items accompanied by images and diagrams. This writing style was also observed by Sinclair (1997), who noticed a variability of sentence structures, phrases and words used in this genre. The aim of each lecture presentation was to facilitate lecture delivery by introducing basic concepts to all first year medical students (see Appendix I). Lecture slides were authored and delivered by medical specialists who gave lectures in the faculty of medicine. Slides included key facts that medical students needed to know in every lecture and they were made available to students prior to lectures to help them prepare in advance.

Permission to use the texts appearing on the PowerPoint presentations was granted from the faculty as well as individual members of teaching staff and all textual data included in power point presentations were compiled in the Online Resources Sub-corpus (ORS). Upon gaining lecturers' permission to access their *lecture slides presentations, files were downloaded from the online shared repository and materials in .pptx and .pdf format were converted into .txt form. In addition, a similar process of typing in information from visuals, such as pictures and diagrams (see section 3.3.1), was followed. Finally, a total n. of 122 lecture presentation files resulting in 206,025 running words were compiled into the ORS sub-corpus.*

3.4.3 Tutorial notes

As part of their medical education, first year students were introduced to the written academic genre of the tutorial texts. Texts were divided into sections each of which would focus on a specific part of the body that was introduced in previous lectures. The notes came in the form of a description of a patient's scenario with information regarding their current health status and medical history. Upon providing this information, students needed to discuss related questions, for instance, what are the possible causes of a patient's problem and how they would deal with it in a given situation. This type of task is called Problem Based Learning (PBL) because they get the students to experience a typical example of medical professionals' lives. Similarly to the lecture slides, tutorial notes as a genre were intended to be used in class and lecturers had the opportunity to clarify or extend on topics briefly, as their role was that of the facilitator. In addition, students had the chance to ask questions to their fellows and instructor as well. Thus, the genre of tutorial notes is written but it was used to prompt oral discussion, questions and answers. The tutorial texts were key for the conduct of the weekly tutorial sessions held in smaller groups of people and participation was strongly encouraged. The tutorial notes were available online via the Blackboard portal and allowed downloading directly from the website and a total of 90 pages were downloaded. Each page appearing online was selected and pasted directly onto a .txt file format resulting in 16,686 running words (see Appendix J). As medical tutorials made use of learning and teaching materials, permission was acquired to access the texts and use them to compile the ORS.

3.4.4 Computer Practicals (SCALPEL)

The Computer Practicals (SCALPEL) resource was available online and aimed at advancing medical students' problem-based learning (PBL) by means of providing *more interactive activities based on case study scenarios. Texts from the SCALPEL resource belong to the written academic genre, they were utilised during individual study time. The SCALPEL platform provided medical students with interactive activities involving case studies and, similarly to the tutorial texts discussed in section 3.4.3, their aim was to position the students into a variety of medical scenarios and ask PBL questions regarding the choices that they would make had they been practising doctors. The scenarios were then accompanied by True/False questions and students were requested to submit their answers online. This offered medical students the opportunity to consider the options provided in each case and reach a decision. At the bottom of the webpage, there was an automated calculation of the correct answers total score along with feedback on incorrect answers (see Appendix F). The SCALPEL resource was suggested to students to study it independently to advance their problem solving skills and further consolidate the topics introduced in lectures. The computer practicals included five broad sections and resulted in 7,942 running words and they were directly pasted on to a .txt file prior to being compiled in the ORS.*

3.4.5 Online e-learning Materials

Similarly to the computer practicals discussed in section 3.4.4, e-learning materials were optional to first year medical students to study at their own will and pace in order to strengthen their understanding of the medical knowledge that they were introduced to in the discipline. The e-learning materials belong to the written academic genre, they included supplementary materials on topics already discussed in class followed by images and provided the specialised anatomy terms for body parts or cell parts, which went in line with related lectures that were delivered during the semester (see Appendix H). The e-learning materials as a genre was used in written mode only with a view to extend knowledge. It consisted of 70 thematic sections resulting in a total of 867,462 running words.

Once data was compiled from the PiPs, PowerPoint presentations, tutorials, computer practicals and e-Learning materials on to the ORS, it resulted in a total of 1,170,081 running words. Once the ORS was combined with the TS, it resulted in the Medical Receptive Corpus (MEDREC). Thus, the MEDREC involves a compilation of a number of different texts from the Textbook Sub-corpus (TS)

(927,546 running words) and the Online Resources Sub-corpus (ORS) (1,170,081 running words) into one large corpus of 2,097,627 running words. Table 8 summarizes the MEDREC corpus structure.

Table 8: The Medical Receptive (MEDREC) Corpus Summary

	MEDREC Sub-Corpora	Resources	Description	Running Words
MEDREC CORPUS	The Textbooks Sub-corpus (TS)	textbooks	36 recommended textbooks sampled up to 10%	927,546
	The Online Resources Sub-corpus (ORS)	lecture slides	122 power point slides between 10 to 50 pages each	206,025
		PiPs	577 online pages	71,966
		tutorial notes	5 tutorial files of 90 pages in length	16,686
		computer practicals (SCALPEL)	5 sections with a total of n.=25 interactive questions with spaces for providing answers and automatic scores calculations in each	7,942
		e-learning materials	70 themed e-learning interactive problem based learning (PBL) sections	867,462
			Total n. of running words	**2,097,627**

3.5 The Learning and Teaching Resources (LETERs) Analysis

As mentioned in section 3.2.1, the MEDREC played a key role in answering the first research question (see section 1.4). Analysis of the lexical density of technical and sub-technical vocabulary can make it possible to shed light on the type of vocabulary found in texts in proportion to the total LETERs in order to gain a better understanding of the degree of richness of technical and sub-technical receptive vocabulary in LETERs texts.

In order to examine the load of technical and sub-technical vocabulary in each of the six resources that have been compiled in the MEDREC, separate lexical density analysis on the technical and sub-technical vocabulary was conducted. Due to the *fact that the present study involved a large volume of language data, each of the resources that belongs to LETERs was analysed by implementing corpus analysis. The type of language that is reflected in the MEDREC corpus is the written language of multiple learning resources that medical students utilized for their learning of their subject knowledge. The genres that are represented in the corpus are balanced in that the majority of them were captured in their entirety, thus, they reflected the sum of disciplinary texts that medical students encountered over the period of one semester. This has an impact on the representativeness of the corpus itself since it mostly compiled full, authentic and balanced texts, thus, it reflected the majority of the linguistic input that medical students gained over the period of one academic semester.*

A type of analysis that could have been implemented in the present study is Lei and Liu's (2016 utilization of Gardner and Davies (2014) analysis protocol and Coxhead (2000) frequency suggestions, on the text. Then, the Stanford CoreNLP program along with the POS tagger was run and lemma were analysed, not families. The analysis was later on scripted in Python (a programming language), and elements such as frequency, range and dispersion were analysed. While Lei and Liu's (2016) proposed methodology seems to have the potential to facilitate investigations in the field, it was not practically possible given that the analysis of the MEDREC data took place prior to this publication and by the time this paper was published, the RECREC had already been designed and the data was collected.

Regardless of this fact, such thorough analysis may often lead the researcher to cherry-pick which words to include in the wordlist from the POS analysis. Running a corpus analysis with the original textual data and looking into the percentage covered along with frequency and range data offers a broader perspective of vocabulary in use. Specific areas to consider are frequency of occurrence and range in the form of types, which are original words in use that have not been classified into one category or another. At this point, it should be mentioned that Liu and Lei's (2016) study is indeed a very meaningful one in terms of setting the pace for future research in the field. However, the present study is limited to the corpus analysis tools and knowledge that were available at the time when it took place and the analysis of texts in the form of tokens add to it's originality that led towards the development of an output from an open-ended perspective.

Given that corpus analysis software are effective in processing specialised vocabulary and assist in conducting automated, simultaneous and efficient language data analysis (Sanchez Ramos, 2020), the RANGE corpus analysis software was selected for the purposes of the present study. The RANGE has the potential to process language data in large volumes and investigate the lexical density of vocabulary usage in them. Another advantage of the RANGE is that this corpus analysis software is available online free of charge. In order to conduct the lexical density analysis of technical and sub-technical vocabulary of the LETERs, all TS and ORS resources included in the MEDREC were examined both separately and as a whole in a single file. In this way, both specific and general conclusions were drawn on the profile of Learning and Teaching Resources (LETERs) per resource and for the total 6 resources with the total number of running words profiled reaching to 2,097,627, as seen in Table 8.

The lexical density was analysed in relation to the findings from corpus comparison between the MEDREC and the BNC K25 Corpus (for a discussion on BNC and technical and sub-technical vocabulary classification and identification in texts, see section 2.9.1). As discussed in section 2.9.1, the lower level lists, for instance BNC1-BNC3 were associated with more generic vocabulary (Schmitt and Schmitt, 2014) while the higher level BNC wordlists were indicative of more demanding vocabulary, specifically, the BNC4-BNC14 was classed as sub-technical and the BNC15-Off Lists as technical vocabulary in English (Hsu, 2013). Upon running the corpus comparison analysis, the corpus output was entered on an excel file to assist data analysis of the findings on technical and sub-technical vocabulary density percentages reflected in each of the LETERs. The lexical density of LETERs in terms of technical and sub-technical vocabulary included in them was summarized and documented together with detailed findings for each compiled resource in section 4.2.1.

3.4.6 LETERs Usage Ranking

Given that LETERs play an important role in the design of the present research study, it was vital to examine medical students self-reports on their usage of the six types of LETERs resources (e.g. textbooks, PiPs, lecture slides, tutorial notes, computer practicals and online e-learning materials). To confirm usage of LETERs throughout the first semester of medical studies (see section 3.9), participants *were given a brief questionnaire to fill in at the end of the term requesting them to confirm the resources they had utilized throughout their initial semester of studies. The short questionnaire requested participants to rank the resources they had utilised for their own study and it was distributed by the end of the first academic semester on the same day and place as the post-task. Upon confirmation of use of LETERs by participants, it would become possible to validate whether the RecRec research instrument, that was designed to test receptive vocabulary knowledge, was reliable or not. Medical students were requested to rank the LETERs according to their preferences. The LETERs options were: dictionary, textbooks, lecture slides, PiPs, computer practicals and online websites (see sections 3.3 and 3.4.1-3.4.5). The LETERs ranking task was administered and distributed at the same time as the RecRec post-task (see Appendix Y). This ensures that the medical students that took part in the present study actually read and used the LETERs to gain medical knowledge during their independent study. The data was entered on an SPSS spreadsheet and findings are discussed in sections 4.2.1 and 4.2.2 and 4.2.3.*

3.5 The Receptive Recognition (RecRec) Task Construct

Describing the construct of the present study at this stage was deemed as important prior to in-depth discussion on the methodological steps on sections 3.6.1 to 3.6.8 that follow. This part of the methodological analysis is concentrated mainly on the second research question that the present thesis intends to answer (see section 1.4). In order to answer the second research question a discussion regarding the instrument design and process of data analysis is necessary. The technical and sub-technical vocabulary of first semester LETERs was examined by means of innovating the Receptive Recognition (RecRec) Task (for a more extensive discussion on LETERs, see sections 2.3 and 3.5). The RecRec Task follows Nation's (2020) stipulation that "Testing word knowledge requires careful thought about the purpose of testing, the aspects and strength of knowledge to be tested, the effects of the test item type, and the people being tested" (2020:15). In light of Nation's (2020) suggestion, the RecRec is an evaluation tool that was designed to cover the methodological demands of the present study with a view to measure medical students' degree of receptive word recognition. The specific areas it focused on relate to the examination of technical and sub-technical lexical items at the beginning and at the end of first *semester of medical studies. This type of vocabulary study does not intend to examine all aspects of vocabulary knowledge and analysis, such as polysemy, MWUs or collocations. However, it is focused on receptive recognition due to the fact that it is the first type of receptive knowledge that is involved in the reading of texts (for further elaboration on this, see sections 2.5.1 and 2.5.2). The participants of the present study were actual medical students both L1 and L2 in their first year of medicine who entered the department as lay and attempted to acquire a number of lexical items that were associated with their subject of discipline during their first months of medical education.*

The RecRec Task included an equal amount of technical and sub-technical vocabulary representing 60%-99% of lexical coverage. It was administered during medical students' first week of studies and one week after the end of their initial academic semester of medical studies. To maintain consistency in findings, data entry and analysis, the RecRec Task was delivered in the same shape and form both as a pre-task and as a post-task (see Appendix X and Y).

The RecRec task emerged as a result of the generation of a word-list of 41,625 running tokens covering 60%-99% of the MEDREC corpus including redundant items such as abbreviations and words with numbers attached to them. The follow-up total upon exclusion of redundant items is mentioned in section 3.6.3. The wordlist was then categorised based on the degrees of lexical coverage into 40 sub-lists (see section 3.6.3). Then, the 40 sub-lists were simplified into bands of lexical coverage (see section 3.6.6). This language data analysis and classification laid the foundations for the receptive word recognition (RecRec) task (see section 3.6.8). Analysis of responses from the RecRec task aim to increase understanding with regard to subjects' degrees of receptive recognition of technical and sub-technical vocabulary used in their disciplinary materials during the beginning and end of their initial semester of medical studies.

3.5.1 Construct Validity

Literature on construct validity suggests that assessment tools can be reliable in cases when they are able to represent individuals' degree of true competence in the area they examine (Bachman, 1990; Hamp-Lyons, 1990; Douglas, 1995 and Bachman and Palmer 1996). Therefore, it was deemed as important to consider *whether the type of receptive recognition task that would be provided to participants was fulfilling this purpose.*

Given that the RecRec task intended to examine medical students' receptive competence from their usage of LETERs, it was important to verify whether participants actually used them prior to administering the RecRec pre-task and post-task. Since the pre-task was administered at the beginning of the semester, it was impossible to gain an accurate picture as regards to the usage of LETERs for independent study purposes due to the limited time medical students had to familiarize themselves with the LETERs. Thus, administering the ranking task (see section 3.5.1) on medical students' preferences for usage of LETERs at the end of their academic semester was deemed as appropriate given that by then they would have established their ideas with regard to their effectiveness and have set preferences for their usage. The ranking of the LETERs resources task described in sections 3.5.1 and 4.2.3 of the present study aimed to increase the validity and reliability of the present study.

The vocabulary construct in the present study follows the definitions of technical and sub-technical vocabulary discussed in sections 2.8 and 2.9. The identification of technical and sub-technical vocabulary follows reliable criteria in terms of corpus compilation, analysis and identification of target vocabulary with the potential to replicate the present study in the future in line with Gablasova (2019) and as outlined in sections 3.6.4 and 3.6.5. In addition, the classification between technical and sub-technical vocabulary underwent no subjective bias. Instruments such as the semantic rating scale was not implemented as part of the data analysis due to the large size of the corpus (Quero, 2015; 2017) and, instead, analysis was based on sufficient evidence-based data from mirror corpora analysis (see sections 2.9.4; 3.6.4 and 3.6.4).

3.5.2 Receptive Word Recognition (RecRec) Task Design

At the time of data collection, there was a lack of a standardised test focusing on technical and sub-technical vocabulary in medicine; this led to the need to design and administer one for the purposes of the present study. The receptive word recognition (RecRec) Task was relied on data from a textual corpus compilation of authentic reading materials that medical students utilized during their initial semester of academic studies. Given that receptive word recognition is acquired *first during the process of learning new vocabulary from reading (see section 2.5.1) and has the propensity to expand (Stoeckel, McLean and Nation, 2020), it was deemed as appropriate to examine medical students' receptive recognition (see sections 2.5.1 and 2.5.2). By investigating the receptive vocabulary recognition at two different stages of their course (beginning and end of the semester), it can be possible to examine the extent of medical students' word recognition in relation to opportunities they had for incidental vocabulary learning through LETERs (see section 3.2.1). The following sections aim to outline how the LETERs language data were compiled on the MEDREC corpus following language data processing such as: the generation of a wordlist based on lexical coverage (section 3.6.3) and its' classification into 40 sub-lists (SLs) (section 3.6.4).*

In addition, at the time when the analysis of corpus data took place, corpus analysis software such as Wordsmith (Scott, 2008) and Wmatrix (Rayson, 2009) were only available on their paid versions. Aiming to utilize the data using free corpus analysis software, the ProtAnt (Anthony and Baker, 2022) and Wordcruncher were considered as possible corpus-based analysis software because they offered the option to measure word frequency and classify data into lists. However, they could not provide additional information with regard to how many of the compiled sources included a given lexical item within the corpus and how many times they appeared in each of the sources included in the MEDREC. Another software that was freely available at the time of data analysis was the RANGE; it could accurately construct wordlists, calculate frequency, coverage and range. Therefore, the RANGE was the used MEDREC corpus analysis software. The output data analysis for the identification of the compiled resources involved the wordlist generation (section 3.6.4), and identification of technical and sub-technical vocabulary (section 3.6.4), the simplification (section 3.6.6) and selection process (section 3.6.8).

3.5.3 Analysis of Data from the MEDREC Corpus Lexical Coverage

Analysing language data by means of lexical coverage can be made possible by using the features available from the RANGE corpus analysis software (Chung and Nation, 2004; Hsu, 2013, 2018; Dang, Coxhead and Webb, 2017; Quero, 2017). The utilization of the RANGE corpus analysis software does not imply that *it has no limitations that would make it more user friendly. For instance, it did not import data in forms other than .txt unlike #LancsBox and the Antconc software. This lack of potential resulted in time consumed on performing text conversions that would have been otherwise unnecessary. In addition, the RANGE cannot generate keyword lists or concordances unlike Wordsmith. Finally, RANGE is not capable of processing special characters or languages other than English, as it is the case of Antconc. As such, in the context of the present study, it can be argued that RANGE lacked substantial features which, although they were deemed as not necessary within the limits of the present study, they could have provided invaluable insights to the researcher and facilitate understanding and interpreting of the data. The lexical coverage feature available at the time of the research was part of the RANGE software (Heatley and Nation, 2002). In order to assess the lexical coverage of all items included in the MEDREC corpus, the RANGE software was run and the lexical coverage option was selected for an automatic calculation. The output included word items covering 5.36% of the corpus up to 100%. Lower degrees of coverage percentage suggest wider usage within the corpus and, thus, can be indicative of more opportunities to readers to familiarize themselves with them and vice versa. The output from the lexical coverage analysis of language data from MEDREC, which totalled to 38713 running words upon clearing the rough output data from abbreviations and numbers appears in Appendix O and in Appendix M, which includes a short version of the longer lexical coverage wordlist that was produced as a result of the MEDREC analysis.*

Analysis of the language data included in the MEDREC LETERs suggests that in most cases lower percentages of lexical coverage were indicative of more widely used words in LETERs. Upon observing lexical coverage analysis on LETERs, it was found that the word the covers 5.36 % of the corpus, of covers a 9.14% and and covers 11.89% of the corpus. It became evident that basic word items were highly frequent in the corpus while their lexical coverage was relatively low. Given that the word items mentioned above belong to General English, it is likely that they might be familiar to medical students due to the fact that they were expected to have encountered them in written texts previously (see section 2.9.4). In addition, at a moderate percentage of lexical coverage were words such as phosphate (62.71%) along with words such as stomach (62.73%) and leads (62.73%). Another example could be drawn from words belonging to higher degrees of lexical coverage such as streptogramins (80.01%), messenger (80.19%) and analgesia

(80.32%). These words belong to the 80% level of lexical coverage and for medical students who were familiar with them, it signifies that subjects recognised an approximate 80% of the words introduced in a subject-specific text. Furthermore, if medical students were in the position to know words such as: mesencephalon, mesenchyma or metacarpal, it is assumed that they can be in the position to be familiar with 99% of the vocabulary appearing in first year medical texts. Such finding can be considered as sufficient for fluent reading (Harrington, 2018), thus, it may not require looking them up at a medical dictionary.

As shown above, vocabulary belonging to lower percentages of lexical coverage can be considered as basic. Thus, a threshold had to be established which would include vocabulary items of medium difficulty as well as advanced. In order to achieve this, a number of frequent words was excluded from the MEDREC lexical coverage output. More specifically, lexical items ranging between 1-59% of lexical coverage were eliminated for the purposes of this study based on the assumption that these lexical items have the propensity to occur frequently in English and students would be expected to be aware of them prior to the commencement of their medical studies. Examples these words were: of (9.14%), is (19.19%), other (30.18%), skin (40.22%), brain (50.43%) and cholesterol (59.49%) (for samples of items covering 5.36%-59.99% of the corpus, see appendix N). This is because the majority of participants had taken biology classes (or equivalent) prior to their entry in the medical school (see section 3.8.2). Therefore, vocabulary between 60%-99% level of lexical coverage was considered for the generation of the receptive word recognition task design (RecRec). In addition to this, the lexical coverage output did not provide any information regarding the sub-corpora, where each of the lexical items consisting the MEDREC came from. Specifically, it was deemed as important to investigate not only the lexical coverage of each lexical item included in the LETERs wordlist but also their range (for a discussion on word range, see section 2.9.3). Given that the RANGE software provides a unique range number, which signifies in how many sources the item was located, it does not specify which sources they were. For this reason, a follow-up analysis of the output was conducted with a view to identify in which source(s) words that form part of the lexical coverage wordlist were found (see section 3.6.4) in order to better understand the LETERs corpus data input prior to selecting which representative items to include in the RecRec task.

3.5.4 Categorization of Corpus Data into Sub-technical and Technical Vocabulary

Thus far, the sub-technical and technical vocabulary were discussed in sections 2.8 and 2.9. However, categorizing the two types of vocabulary from the corpus output data needed a frame of reference. The present study utilises a standardised framework for the classification of technical and sub-technical vocabulary. The process that was followed in order to carry out this categorization involved a corpus comparison approach, between the LETERs wordlist data and a mirror corpus (see section 2.9.4). The use of the BNC as a mirror corpus in corpus analysis offers accurate and impartial information in identifying both the sub-technical (Hsu, 2013 and section 2.9.1) and technical vocabulary (Ripamonti, 2015, see section 2.8.3) in medical texts.

Specifically, vocabulary from the BNC headwords was classified into three broad domains: high frequency, mid frequency and low frequency (Nation, 2004; Hsu, 2013 and Schmitt and Schmitt, 2014). Thus, the BNC1-BNC3 headwords tend to include words that are basic in English (e.g. a, train) and appear frequently in the GSL (West, 1953) as well as the AWL (Coxhead, 2000). This claim was verified by Hsu (2013) and Schmitt and Schmitt (2014) who observed that the AWL items overlapped with the BNC1-BNC3 and its' basic meaning can be familiar to medical students (Hsu, 2013), although it can also carry technical meanings too (Coxhead, 2018; Hsu, 2018). Thus, reaching the 3,000-word families goal signifies an important achievement in linguistic acquisition (Hsu, 2013).

In addition, a total of 76 words from the BNC4-BNC14 lexical items (e.g. closure, deficiency) (Hsu, 2013) overlapped with the AWL (Coxhead, 2020) and included mid-frequency vocabulary items. Thus, they were classified as sub-technical vocabulary (Hsu, 2013). Combining the AWL along with the BNC in mirror corpus analysis as impartial sources of lexical data analysis indicates the kind of usage of a word in English. More specifically, both Hsu (2013) and Coxhead (2000) considered that both the BNC and the AWL provide evidence that a term may be sub-technical due to its broader usage within various academic disciplines in English. At the same time, vocabulary above BNC15 (e.g. nephritis, ileum) was considered as technical in line with Hsu (2013). Specifically, it was claimed that the rarely used items in English or items that do not belong to any wordlist may *be technical without necessarily needing the expert knowledge of a native speaker of English to validate them (Nation and Chung, 2004). The distinction between technical and sub-technical vocabulary is comprehensive, it has been effectively used to investigate medical texts and it is a user-friendly option particularly for data-driven studies. Given the amount of textual data collected for the purposes of the present study, a combination of Hsu (2013), Schmitt, and Schmitt (2014) frameworks for word classification was adopted. Therefore, in this study, the method for approaching the two types of vocabulary in medical texts is based on a combination of previous approaches adopted in corpus-based studies by Coxhead (2000), Nation and Chung (2004) and Hsu (2013). Word items between BNC1-BNC3 were eliminated on the basis that this type of vocabulary was not investigated in the present study. This allowed focus on linguistic items that belong to BNC4-BNC25/Off-list, which resulted in a wordlist of 4,981-word forms/tokens wordlist that included both technical and sub-technical vocabulary in it. Then, the amount of sub-technical vocabulary included in the wordlist was extracted for the purposes of the present study. A total of 617 sub-technical vocabulary items wordlist and a 4,364-items technical vocabulary list were identified and stored in separate files. The unequal representation of the technical and sub-technical vocabulary can be associated with the higher lexical density of technical vocabulary compared to the sub-technical in MEDREC texts, as reported in sections 4.2.1 and 4.2.2.*

In addition, it is worth mentioning here that the present study is looking into word forms (tokens) and not into families or types (see section 2.9.1). This is because it aimed to study the specialised vocabulary of the discipline and token analysis can increase specificity of findings by knowing which specific word items are looked at. Fraser et al. (2016) held a similar view in that word families may encapsulate significant information on specific word form details, e.g. spelling, form and recognition. Tokens, as a unit of calculating the number of words is beneficial for the purposes of the present investigation and analysis of the vocabulary belonging to a specialised academic field such as medicine (Coxhead, 2018). Taken the above into consideration and once technical and sub-technical vocabulary identification process was completed in the MEDREC corpus, all identified technical and sub-technical running words from the LETERs wordlist were further classified into their corresponding lexical coverage percentage, as discussed in the following section.

3.5.5 The Generation of Medical Sub-Lists (SLs)

In order to convert data from technical and sub-technical vocabulary discussed in the previous section into measurable units for the test design process and analysis, the lexical coverage vocabulary output was classified into its' corresponding degree of lexical coverage ranging between 60%-99%. As discussed in section 2.9.1, a process of exclusion was followed for vocabulary items with very low degrees of lexical coverage. This is because vocabulary that belongs to lower levels of lexical coverage such as 1%-59% can be familiar to medical students and, therefore, it was eliminated from the wordlist. On the other hand, vocabulary that covered 60% to 99% of the corpus was considered as more demanding and potentially new to first year medical students. Thus, the vocabulary ranging between 60%-99% of lexical coverage was further classified into 40 Medical Sub-Lists (SLs) with 1% lexical coverage difference each in line with Hsu (2013). Thus, each-sub list was based on a 1% unit difference from other sub-lists. It aimed to facilitate the process of analysis of the type(s) of vocabulary included in the RecRec Task, as seen in Table 9 below.

Table 9 presents each sub-list (SL), which was numbered and duplicated for technical and sub-technical vocabulary separately and represented degrees of lexical coverage resulting in a total of 40 sub-lists (SL1-SL40).

Table 9: Classification Example of the Lexical Sub-lists (SL).

Lexical Sub-Lists (SL)							
SL1: 60%	SL6: 65%	SL11: 70%	SL16: 75%	SL21: 80%	SL26: 85%	SL31: 90%	SL36: 95%
SL2: 61%	SL7: 66%	SL12: 71%	SL17: 76%	SL22: 81%	SL27: 86%	SL32: 91%	SL37: 96%
SL3: 62%	SL8: 67%	SL13: 72%	SL18: 77%	SL23: 82%	SL28: 87%	SL33: 92%	SL38: 97%
SL4: 63%	SL9: 68%	SL14: 73%	SL19: 78%	SL24: 83%	SL29: 88%	SL34: 93%	SL39: 98%
SL5: 64%	SL10: 69%	SL15: 74%	SL20: 79%	SL25: 84%	SL30: 89%	SL35: 94%	SL40: 99%

In addition, information regarding the vocabulary sources of each lexical item, as discussed in section 3.6.4, were stored in the sub-list data for each of the 40 sub-lists reported in Table 9. For instance, in the SL21 covering 80%-80.99% of text coverage, included information of the technical or sub-technical vocabulary identified together with all six LETERs sub-corpora that were analysed in RANGE software. This made it possible to examine which of the items in SL21 came from *textbooks, PiPs, lecture slides, tutorial notes, computer practicals and e-learning material resources in order to help make choices that are more informed at the time when the lexical items would be selected for the forthcoming RecRec Task (see section 3.6.8). Taking the above into consideration and in line with the reverse principle to lexical coverage discussed in section 3.6.3, assumptions could be generated as to the degree of subjects' receptive vocabulary familiarity upon taking the RecRec task, which reflects all 40 SLs. Thus, it can be argued that depending on individuals' ability to recognise the spelt format of words based on findings from the lexical coverage output, it can be possible to predict their degree of receptive word recognition (see section 2.9.3). The SL1-SL40 items were then examined with regard to their potential to select items that could represent the SLs equally in the RecRec task for both technical and sub-technical vocabulary. Given that each 1% of lexical coverage included a significant number of vocabulary in SLs and not all items could be tested on the RecRec task, that had limited space and time constraints, a decision was made to simplify the items belonging between the SL1-SL40 by grouping them into bands of lexical coverage, as discussed in the section that follows.*

3.5.6 The Generation of Lexical Bands

As discussed in the previous section, the 40 medical SLs were generated based on their degrees of lexical coverage from 60%-99% (see section 3.6.5), which in the present study they emerged from the automatic calculation between word frequency in relation to the cumulative percentage for each word on the RANGE software (Nation, 2006). In this way, the bias that relates to relying only on the degree of frequency amongst words that are produced in a given context can be avoided (Coxhead and Demecheleer, 2018). In addition, the source(s) of running words included in the MEDREC corpus output and medical sub-lists (SLs), which explained their range score, were already identified at that stage (see section 3.6.4).

As a result, an additional simplification action was taken in order to simplify and downsize the wordlists for the purposes of the design of the receptive recognition (RecRec) task. Specifically, the 40 sub-lists (SLs) representing 1% difference of lexical coverage were merged and classified into 8 Lexical Bands (LBs) which were representative of 60-99% of lexical coverage with 5% difference each, as shown in

Table 10. For instance, Band1 includes 5SLs (SL60, SL61, SL62, SL63, SL64) and items belonging to Lexical Band 1 represented 60%-64% of lexical coverage in the MEDREC corpus. As discussed earlier (see section 2.9.3), students' awareness (or lack of it) with items from each of the lexical bands may suggest a different degree of lexical awareness of word form recognition on the basis of the reverse lexical coverage principle. Therefore, the bands provided in Table 10 were designed in order to be representative of group percentages of receptive word recognition.

Table 10: The eight bands that were generated based on the sub-lists (SLs) that were selected to be included in the RecRec Task.

Lexical Band (LB)	Lexical Sub-lists (SL) included in each band
Band1	SL60, SL61, SL62, SL63, SL64
Band2	SL65, SL66, SL67, SL68, SL69
Band3	SL70, SL71, SL72, SL73, SL74
Band4	SL75, SL76, SL77, SL78, SL79
Band5	SL80, SL81, SL82, SL83, SL84
Band6	SL85, SL86, SL87, SL88, SL89
Band7	SL90, SL91, SL92, SL93, SL94
Band8	SL95, SL96, SL97, SL98, SL99

One of the test types that was considered for the study of receptive recognition was the open-ended questions task. For instance, students would be presented with a lexical item, for example, warfarin, and be asked a question such as: what does warfarin mean?. Although it might seem like a straightforward type of test, the most challenging part lies in the establishment of a reliable rubric/key for evaluating the degree of correctness of each answer since more than one answers can be possible. Moreover, the test may move beyond the limits of receptive recognition to test medical knowledge, which is not the main objective for setting up the intended RecRec pre-task and post-task.

Another test type is the multiple-choice test. For example, a student would be introduced to a word item in context and be provided with a number of distractors along with the correct answer. In the context of the present study, one of its caveats is that given the busy schedule that medical students follow each *day, it could potentially take more pages and time to complete, thus, it may not be a user-friendly option. In addition, it may overwhelm the students and potentially prompt subjects into guessing the meaning, thus, overestimating their skills on receptive recognition (Culligan, 2015).*

One other option would be to provide participants gap filling tasks based on authentic medical texts. The gaps could be filled in by choosing the correct answer from a battery of possible distractors. Alternatively, lexical knowledge based on paragraphs taken from authentic texts could be tested by highlighting a lexical item and providing a battery of closed or open questions. While, in an ideal world, research participants may voluntarily have plenty of time to participate in research tasks, the reality was particularly challenging for the participating medical students. This is because most of them would sacrifice some of their personal time to take part in this study, and this time was very limited due to the increased demands that they had to fulfil in their program. In this case, it would go without saying that designing a task that looked long and wordy such as the one discussed would have many pages and lots of text to read. This could have led to tasks being half-answered or not answered at all, thus, limiting the participation rate of medical students in this study.

Another option was the Vocabulary Levels Test (VLT) (Nation, 1990) in order to assess medical students' vocabulary size in line with Quero (2015). This test is a meaning recognition test in that it assesses the form and the meaning of a word item. It is standardised and can be given to learners in order to assess their receptive vocabulary on 2K, 3K, 5K and 10K lexical items. This option was an appealing one given that the test has been piloted and standardised by Paul Nation and utilised by a number of researchers worldwide. In addition, according to Mochida and Harrington (2006), the differences between the VLT and Yes/No tests (see below) were minimal. Although the VLT seemed to be a good option for learners of General English, it was considered as not suitable to use in the sample population recruited in the present study. This is because the VLT mainly assesses word families and that could potentially lead to overestimated results on vocabulary awareness given that a tick on one member of a word family could represent awareness of most family members where each word belongs to (Stoeckel et al., 2020). Its' updated version by Webb et al. (2017) follows a similar principle of assessing different strands of words according to their frequency.

Furthermore, it is limited to the first 5K words in English. In addition to this, technical and sub-technical vocabulary used in medicine is highly specific and even with additional adaptations to the original VLT it would still be an unsuitable method to assess receptive vocabulary mainly because it is geared towards assessment of General English and not Medical English vocabulary competence. In addition, it is not designed to test technical and sub-technical items that are typical of the medical field.

3.5.6.1 The Yes/No Type of Test

A further alternative to the ones presented here is the yes/no test, which is time efficient and reliable to use in the context of the present study. It was devised by Anderson and Freebody (1983) and requires its respondents to check whether they know a word or not by ticking in the box provided. The yes/no test is popular in assessing receptive recognition of word form (Castellano-Risco, 2018). It belongs to a family of close-ended types of tests and vocabulary items included in them should be provided without context (Miralpeix and Meara, 2014). In addition, it is student-friendly in terms of its' form and the yes/no test it was considered as a reliable tool when assessing respondents' answers (Pellicer-Sánchez and Schmitt, 2012; Dang, 2017). According to Huibregtse et al. (2002) "a yes/no test consists of two different kinds of items: real words and pseudowords" (2002:227). The pseudowords, although may sound or look like existing words in a language, they bear no meaning at all. According to Hagiliassis et al. (2006) these words, although unreal, they are in line with spelling conventions in a given language, such as English. Lexical items that are part of these kinds of tests are given to learners in written form to tick next to the words that they know and leave the ones they do not know blank. In an ideal situation, students should be aware of the existence of pseudowords in the test but should not be told which ones they are. The advantage that this testing instrument offers relates to its simplicity of usage and time effectiveness (Miralpeix and Meara, 2014) which, in the case of the present research, it was vital given that participating subjects' time available for the present study was minimal. In addition, as Miralpeix and Meara (2014) correctly point out, "Although there is no perfect scoring method, close approximations can be obtained [in yes/no tests] and these [the yes/no tests] are useful for a variety of purposes, such as having an indication of the learner's lexical proficiency in a quick and easy way" (2014: 33). On the other *hand, it has been observed by Castellano-Risco (2018) that this test cannot effectively assess vocabulary bands or vocabulary size. This is probably because to this date, no study adapted the Yes/No test in a way that this can be achievable. The present study is an opportunity to adapt the Yes/No test making it possible to include an equal number of representative items from different bands of lexical coverage. This can extrapolate findings and make inferences with regard to vocabulary size on the basis of the scores received in the Yes/No test, which is the type of test used for the RecRec task (see section 3.6.6). Thus, the methodology followed in the present study is unique as it utilised a theory of text evaluation, such as lexical coverage reversely with a view to examine and extrapolate the vocabulary items that medical students have basic knowledge of features such as spelling through the Yes/No test.*

A good example of a yes-no test is the English as a Foreign Language Vocabulary Test' (EFL Vocabulary Test) (Meara, 1992), which focused on L2 students' receptive knowledge of words. The EFL Vocabulary Test was designed on the basis of word frequency from texts (Hindmarsh, 1982; Nation, 1986). The degree of frequency generated a number of levels from the first 1,000 most frequent words to the second 1,000 most frequent words and moved on to measure higher degrees of frequency. In a similar way, the RecRec adopted a similar selection procedure. Specifically, for each of the eight lexical bands examined in this study, a total of 10 words represented each band. This resulted in a total of 80 words for the technical and 80 words for the sub-technical vocabulary while the amount of imaginary words used to enhance reliability was 40. The imaginary words were made out of syllables from real words with attention to their sound.

Then, Meara and Milton (2003) moved beyond visual word recognition testing by suggesting X_Lex vocabulary test, which involved the use of a computer for visual as well as aural word recognition. In the present study, the idea of lexical frequency levels was adapted by means of examining lexical coverage in line with the purposes of this study (see section 3.6.6). However, the concept of test design on both instances was based on the same underlying principle of classifying vocabulary. While the EFL Vocabulary Test was focused on word frequency, the receptive word recognition (RecRec) task was focused on lexical coverage allowing the researcher to extrapolate by making assumptions on the degree of text coverage that medical students could achieve when encountered with learning *and teaching materials (LETERs) of their discipline during their initial year of medical studies.*

However, one of the challenges that this type of test poses according to Harrington (2018) is that although it can effectively assess size, the Yes/No test does not make it certain that the test taker has full awareness of all the meanings of a given word (depth). In addition, it is difficult to guarantee that students' responses to the items were honest. Specifically, it might be that students mark words that they have never heard of and claim that they know them, aiming to get a higher mark. It could also be that participants may make false judgements claiming that they know or have heard of a word being tested, when in reality they do not know it. In order to maintain the reliability of this test, imaginary words, or pseudowords, were necessary to be included in the RecRec task (Meara and Jones, 1987).

Based on the learners' selection of real words and imaginary words, a formula for adjusting the final test score indicating the degree of true lexical knowledge of participants was considered (see section 3.7). One of the features of imaginary words was that they had to read like medical words; to achieve this, they should not look or sound similar to technical or sub-technical items selected for the word recognition task, which, would become the foundation of the Imaginary Words (IW). For instance, the morpheme hemo, from the medical word hemorrhage, and the morpheme thermia, from the word hypothermia made the imaginary word: hemothermia. Another example comes from the morpheme gono, from the word gonorrhoea and the word chlamydia, which formed the imaginary word: gonorrhydia. The imaginary words needed to sound medical to them yet carry no specific meaning in them. This feature was checked by two health specialists, one L1 and one L2 speaker, who were recruited for the purposes of this investigation.

As far as the total number of Imaginary Words is concerned, suggestions vary from one study to another and so far, there is no consensus. This led a number of researchers to develop their own proportion of imaginary words as a means to maintain reliability and validity in Yes/No tests as seen in the following examples.

- *Meara and Buxton (1987) used the proportion of 60 (or 60%) real words to 40 (or 40%) imaginary words.*
- *Meara (1992) used 40 (or 66%) real words and 20 (or 33%) pseudowords per frequency range.*

- *Liu (1998) used a ratio of 50% real to 50% imaginary words.*
- *Masrai and Milton (2015) used a ratio of 100 real words to 20 imaginary words.*
- *Dang (2017) used the ratio of 97 real words to 32 imaginary words.*

As can be seen from the above, there is no agreed consensus as to the proportion of pseudowords and real words in a yes/no test. The receptive word recognition task that the present study is based on aimed at examining a total number of 160 items (80 technical and 80 sub-technical) in a very short period of time. This resulted in an average amount of pseudowords up to 20% of the test. This translates as: in a total of 160 (or 80%) real words, there were 40 pseudowords (or 20%). The use of pseudowords along with the algorithm, which took into consideration the amount of real words and pseudowords for the adjustment of the test scores, aimed to enhance the reliability of the test findings. A detailed description of the algorithm options is provided in section 3.7 and in Appendix T. This section revealed that yes/no test entailed a number of advantages for the purposes of the present study and, as a result, it was the chosen type of task for receptive recognition.

3.5.7 The Receptive Word Recognition (RecRec) Task Description

The chosen test type for the examination of receptive recognition of this study was the Yes/No type of test. As discussed in section 3.5.7, it is advantageous in that it is straightforward with a simple and user-friendly design, ease of administration and marking procedure compared to other types of tests such as the open ended or multiple choice tests (see 3.6.7). The yes/no RecRec task can effectively test medical students' receptive recognition of a total 160 technical and sub-technical items in a matter of minutes. In addition, it looks simple and user-friendly and it gave the feeling to the respondents that it is doable and easy to use from the start even to subjects with very limited time or will to spare. To achieve this quality, meticulous work was conducted with the aim to include representative samples 40SLs representing 60%-99% degrees of lexical coverage, which were later classified into 8 lexical bands for technical and sub-technical vocabulary (see section 3.6.6).

With a view to avoid biased findings that an unequal representation of technical and sub-technical vocabulary might bring about, it was considered that the two *sets of vocabulary should be equally represented but randomly selected and distributed in the RecRec task. Specifically, the RecRec task consisted of an equal number of 10 lexical items following Beglar's (2010) suggestion that for each 1,000 words a total of n. 10 words can effectively represent them. The random choice of words that would represent each lexical band was inspired by previous research in Medical English (ME) by Wang et al. (2008) which effectively selected vocabulary items from different levels of frequency in their corpus. In addition, a total of 8 lexical bands of 60%-99% of lexical coverage in the MEDREC was represented in the RecRec task as discussed in section 3.6.7.*

- *Out of the 8 lexical bands generated for the sub-technical vocabulary, 10 representative word items were extracted from each lexical band (8x10=80 sub-technical words were included in the RecRec Task).*
- *Out of the 8 lexical bands generated for the technical vocabulary, 10 representative word items were extracted from each band of lexical coverage (8x10=80 technical words were included in the RecRec Task).*
- *A total of 40 imaginary words were included in the RecRec, making it a receptive word recognition task of 200 words in total. It should be mentioned here that because pseudowords are unreal words in English, they were not classified as neither technical nor sub-technical. According to Masrai and Milton (2015), pseudowords can "act as gatekeepers to guard against the possibility of the participants guessing" (2015:194). As discussed in section 3.6.7, every effort was made to keep a reasonable proportion of pseudowords in the test aiming to maintain reliability and validity. One assumption regarding the effectiveness of the RecRec task was that if all subjects ticked all lexical items provided as real words without ticking the pseudowords. This could mean that the test was a rather easy one for them. However, this supposition was not confirmed since students had a significant variability in their responses on both pre-task and post-task and different real words and often-different pseudowords were ticked each time.*

The RecRec task aimed to assess students' degree of receptive word recognition. However, asking them whether they could recognize a word or not would make the test lack clarity as students might misinterpret this linguistics term and probably question which words they should recognize against which. To minimize confusion and make the test appear as straightforward as possible in the minds *of busy medical students, the RecRec asked whether participating subjects knew the words included in the RecRec task. The selection of this simple term was aiming to invite students to tick on the words they knew the spelling of without looking deeper into their word knowledge as this would go beyond the limits of the present study. Asking the students whether they knew the words included in the receptive task was inviting them to interpret this instruction word in their own way; however, accessing their word knowledge would involve recognition of spelt form (Szubko-Sitarek, 2015), which is what the RecRec task looked at. With a view to clarify that this task was about recognising word form only, medical students were given oral instructions to tick on the words that they knew their spelt form when the RecRec task was being administered.*

Another aspect of the present study that aids towards maintaining reliability and validity of the RecRec relates to the Ranking Task on the LETERs used by medical students (see section 3.5.1). Specifically, medical students were asked at the end of their term to confirm their usage of learning and teaching materials by means of ranking their preference of their usage as well as other resources of their own. Students' verification of usage of the LETERs can increase the validity and reliability of the findings of the RecRec task based on the ground that they were indeed exposed to the technical and sub-technical vocabulary examined in the RecRec Task.

3.6 Ethical considerations

In order for the present study to be conducted, an Ethics Approval needed to be obtained from both disciplinary institutions: the medical faculty as well as the Faculty of Arts and Humanities at the University of Southampton. The present study was ethically approved on 01/11/2014 by both faculties involved under the ERGO submission Number 12987 and Ethics ID: 9877. Upon obtaining approval, the participant information sheet and consent form was designed and distributed (see Appendix K and L).

The participants of this study were requested to take part in the present study by reading the participants' information sheet. A requirement for participation was to provide a completed pre-task, post task, and permit access to their submitted essay. A total of 115 participants signed the consent form permitting the use of *their receptive and productive tasks for the purposes of the present study. Participating subjects were assured that their data responses would be stored in a password-protected computer that only the researcher had access to.*

3.7 Description of the Research Context

The Faculty of Medicine, where the study was conducted, is based in the UK. The faculty's medical education program was designed to offer a theoretical background about a variety of topics related to the medical science during the first two academic years. It is during that time when medical students acquired medical knowledge in different learning contexts such as academic sessions in large amphitheatres, where they learnt more about the human body, the dissection rooms and tutorial rooms, where they had time to consolidate their learning by working in groups in order to find solutions to problem based (PBL) tasks. From the third until the fifth year of studies, participants would gain more practice in affiliated hospitals, as part of their medical education program, and submit a dissertation. In addition, a small percentage of the medical population would complete their clinical practice years in an affiliated medical school in Germany. Thus far, it appears that medical students were enrolled in a program that would offer them three key stages. Specifically, they would have the opportunity to acquire the theoretical aspects of medicine, apply them into practice in the hospital wards during their practice years and, finally, develop a research interest in order to write their dissertation.

At the time when the present study took place, the majority of medical students entered the medical school upon sitting the A-levels exam, or equivalent, if they came from overseas and achieved high marks in order to qualify their entry. Attendance in the educational settings was not kept; however, it was strongly recommended that medical students attend all lectures, tutorials and dissection practicals sessions. It is during these sessions that LETERs resources such as lecture slides, tutorial notes, PiPs, a selection of computer practicals and e-learning materials (see sections 3.4.1-3.4.5) were utilized to support the clinical information focused during the sessions. In addition, it should be mentioned that each of the sessions described above, as well as resources, were designed and delivered by a diverse population of invited expert clinicians depending on the topic of discussion. For instance, sessions on genetics were delivered by *geneticists, sessions in pharmacology were delivered by pharmacologists, sessions related to skin facts by dermatologists and sessions regarding mental health were delivered by psychiatrists. Thus, the way information was delivered in each session was dependent on the health expert that was involved each time who would design their own lecture slides following the templates and fonts that were typical of the university but being in charge of the type of information included in the lecture slides. In addition, the dissection rooms involved different specialists depending on the type(s) of body parts that were looked at each time. It appears from the above that the context where the present research took place was distinctive and diverse and medical students had the opportunity to learn from experts in their fields through lectures, tutorials and dissection practicals.*

3.7.1 Medical Faculty's Entry Requirements

As discussed in section 1.2, the anonymous faculty where the present study took place is based in the UK, it is well reputed and is a member of a group of British Universities that demonstrate excellence in research and teaching. For British Students an achievement of AAA in A-levels with biology is a key component and equivalent scores were necessary for overseas students. As part of the admission criteria that the medical school set, anyone whose first language was not English, they needed to demonstrate a certificate of English competence within two years of issue. Acceptable certificates were IELTS 7.0, IELTS Academic, PTE Academic UKVI, LanguageCert International ESOL SELT, PSI, and Trinity College London ISE. However, possession of such language competence certificates neither guarantees a successful outcome in academic studies (Daller and Xue, 2009) nor adequately prepares them for the disciplinary vocabulary they would encounter (Dang, 2019). In addition, another entry criterion that was necessary for both L1 participants and L2 participants was the UCAT test, which the participating subjects in this study took, and it examined their competence in biology and medical issues. However, the most up-to-date UCAT (2022) tests examine multiple types of reasoning (situational, abstract, quantitative, verbal and decision-making). Other non-academic criteria for L1 and L2 participants' admission relate to self-motivation, ability to reflect from personal experiences, communication skills, interaction skills and familiarity with the principles of the

UK's NHS. As can be seen from the above, both L1 and L2 subjects had the same entry criteria in the faculty with the exception that L2 participants needed to demonstrate an accredited certificate of English language competence in their application form.

3.7.2 Participating Subjects Backgrounds

The present study recruited medical students during their initial semester of medical studies at a British university. The sample population that took part in the present study aged between 18 and 25 years old and the gender division was relatively equal with 47% of the sample population identifying themselves as males and 53% as females. All participants took an A-level or equivalent in order to enter the faculty and two sub-groups emerged the L1 and L2 participants. From the demographics information that was collected out of the total number of 115 first year medical students who were willing to participate in this study, 93 reported English as their first language (L1) and 22 reported English as a second or foreign language (L2).

The L2 population was considerably diverse yet at the same time limited in number. The language backgrounds that L2 subjects reported as their first were: Chinese Mandarin, German, Malay, Nepali, Russian and Tamil, as seen in Table 11. The lower participation of L2 subjects can be attributed to the fact that there were limited places available for non-UK citizens in the faculty where the present study took place. This made it challenging to collect data from a larger population of L2 medical students that represented a consistent linguistic background. Although the language backgrounds of the participants were different and this might have a representativeness impact on the reliability of the findings (Gablasova, 2021), there was one variable that was consistent and it was associated with L2 participants' level of English language competence.

Specifically, all L2 admitted students in medicine needed a 7.0 in IELTS or C1 in CEFR (discussed in this section), which suggests advanced knowledge of English and some of them spent time in English-speaking countries prior to their application in the medical faculty. Another similarity lies in the fact that L2 participants were introduced to the same LETERs under the same learning and teaching conditions. In addition, the type of vocabulary examined was specific to medicine and it is unlikely that L2 learners' linguistic background (s) might have *put some of them at an advantage. Given that the present study looks at vocabulary size and does not aim to look into subject knowledge of vocabulary terms in depth, it was believed appropriate and viable to classify participants from different linguistic backgrounds into one variable, the L2, for the purposes of this investigation. In addition, it is important to mention that regardless of L2 participants' first language, their knowledge of English was very advanced in line with the entry requirements, which can make it possible to provide reliable findings on the MEDPRO corpus data. With this in mind, participants of linguistic backgrounds other than English were classified into one variable, the L2, to ease the process of data analysis and enhance clarity for the purposes of the present study.*

Table 11: Participants' Linguistic Backgrounds.

Participants' Linguistic Backgrounds					
Languages (in Alphabetical Order)	**First (1st) Language Background**	**Second (2nd) Language Background**	**Third (3rd) Language Background**	**Fourth (4th) Language Background**	**Fifth (5th) Language Background**
Arabic			2		
Chinese Cantonese			1		
Chinese Mandarin	2		2		
Dari				1	
English	93	22			
French		2	6	3	
German	14	3	3		
Greek		2			
Gujarati		1			
Hindi		1	1		
Indonesian		1			
Irish Gaelic		1			
Japanese					1
Malay	2	1	1	1	
Nepali	1				
Polish		1			
Punjabi					1
Russian	1				
Sinhalese		1			
Spanish		2	3		
Tamil	2	1			
Urdu		1			
Vietnamese		1			
Yoruba		1			
Total	**115**	**42**	**19**	**5**	**2**

What is interesting to note is the awareness of additional language(s) by some of the participating subjects. Table 11 demonstrates up to four languages known to participants at the time of the research. This indicates larger awareness of various linguistic systems and vocabularies beyond subjects' native ones at the time of the research. Since participating subjects seem to have utilised higher levels of cognitive skills already in order to acquire a number of different language system(s) other than their own L1 (Jessner et al., 2016), it might be possible that they made use of them for their acquisition of new medical vocabulary, although such hypothesis go beyond the limits of the present study.

Table 12: Participants' Competency in Classical Languages

Classical Languages (Latin and/or Greek)		
	Total n.	**%**
Competency in Classical Languages	28	24.3
No Competency in Classical Languages	87	75.7
Total	115	100.0

Another element that should be mentioned at this point relates to awareness of classical languages such as Latin and Greek, which are the languages that many medical vocabulary items derive from (Stephens and Moxham, 2016). Awareness of Latin and Greek has been positively associated with higher scores in the anatomy component for first year undergraduate students (Stephens and Moxham, 2018). Table 12 demonstrates that 24.3% of the sample population reported awareness of classical languages while a larger percentage (75.7%) claimed lack of awareness. Similarly to information associated with additional L3 or L4 backgrounds, assessing the impact of classical language awareness on medical students' scores goes beyond the scope of the present study. This is due to the fact that the types of courses taken, the years of study, the type of curriculum followed and the level of participants' knowledge of additional (L3 or L4) and classical languages remains unknown. Thus, data on medical students' linguistic backgrounds are provided in this section in an effort to increase understanding of the participating subjects included in the present study.

3.8 Conduct of the Receptive Word Recognition (RecRec) Pre-task and Post-task

Upon piloting the RecRec on one L1 and one L2 medical students, and making use of the feedback provided by the testees in line with Hughes (2003), the RecRec pre-task and post-task task was administered. Out of the total of 221 registered students in the medical course, 216 students participated in the pre-task and 115 took part in both the pre-task and post-task. It was the 115 subjects with matching pre-tasks and post-tasks that were considered in the present study. This is because in order to perform the comparisons between pre-task and post-task performance, as outlined in the second research question (see section 1.4), comparisons between pre-task and post-task performance were necessary for each participant. Lack of either of the two tasks would result in inaccurate findings regarding medical students' receptive vocabulary at the beginning and end of their academic studies in medicine. Participants were not requested to provide their real name but for the purposes of matching their RecRec pre-task and post-task responses as well as their submitted essay, thus, their ID number was required.

All participating subjects were informed about the purposes of this study via the Participants' Information Sheet (PIS) (Appendix K) and they willingly opted in the study without any incentive given to them. All participating subjects had the chance to read the PIS prior to taking part in this study. The implementation of the pre-task and post-task (see Appendix X and AB) was scheduled at a time when students would be finishing their lecture sessions. The medical lecturers introduced the researcher to the student audience and the researcher briefly talked about the project and gave instructions on what students were expected to do to participate in this research. The RecRec task (was then distributed to the subjects as a pre-task during the first week of the initial semester of year 1 and as a post-task upon participants' completion of their examination procedure and submission of their academic essay at the end of semester1. It took four months from the administration of the pre-task for the post-task to take place. All participating subjects took the RecRec task within the university premises and they were expected to provide honest answers and not request the help of friends or other resources in filling in the RecRec task. The researcher was present during the RecRec task administration in order to answer potential questions that *the participants had. Subjects were allowed as much time as they needed. Mobile phones were not allowed and students needed to remain quiet during the process of the RecRec task administration. Students who completed the RecRec task were required to hand it to the researcher while on their way out of the lecture room and they were all thanked for their participation.*

3.9 The Data Entry and Marking Process

The data entry process began once the 115 post-tasks were collected and their unique ID numbers were matched with their pre-tasks and submitted academic essay.Any non-matching tasks were discarded (see section 3.9). Given that access to automated systems for data entry such as the Scantron Test Scoring Machine was not available to the researcher, the matched tasks was digitized manually by entering them into an excel file. Therefore, data responses from 115 pre-tasks and 115 post-tasks were manually entered into an excel file. In addition, each of the 200 lexical items included in the RecRec tasks was entered in an excel file dedicated for technical and sub-technical vocabulary separately. Entry files were generated for each participating student and ticked items were coded with 1 and empty spaces were coded with a 0 following Huibregtse et al. (2002) view, who considered this method as a way of avoiding simplistic entries. Specifically, merit was given to the amount of correct responses (the real words ticked) the missed answers (the real words that were not ticked), the false alarms (the number of pseudowords that students ticked) and the correct rejections (when students correctly left pseudowords unticked) (Huibregtse et al., 2002), as discussed in section 3.7.

The scores adjustment with the Isdt formula (see section 3.7) was further processed in order to adjust the scores accurately for the two types of vocabulary examined as well as the 8 bands of lexical coverage. For each RecRec task the number of total pseudowords per task was further divided by two in order to adjust the final scores for the technical and sub-technical vocabulary separately. This is owing to the fact that pseudowords were not attributed a technical or sub-technical nature and they were present in the RecRec task in order to enhance validity of findings on both technical and sub-technical vocabulary. In addition, during the data entry process, vocabulary was further classified into bands of lexical coverage represented in the receptive recognition task. Although in other *studies such as Masrai and Milton (2015) 30% of the ticked pseudowords would lead to a failed participation, an effort was made to calculate a separate score for each of the 8 bands representing technical and sub-technical vocabulary. In other words, adjusted scores based on the numbers of pseudowords per lexical band were calculated separately in order to ensure that scores on performance of these bands was appropriate and fair. For example, the number of pseudowords that corresponded to technical vocabulary was further divided by 8 (as the total number of lexical bands represented in the word task was 8), and the score was re-adjusted based on Huibregtse et al. (2002) Isdt formula.*

Once data entry was complete, data was transferred into an SPSS file and labels were placed for different variables. The SPSSv24 was utilised to perform statistical operations on participants' performance scores on technical and sub-technical vocabulary for both pre-task and post-task. Overall scores as well as lexical band scores for both pre-task and post-task were entered in the SPSS data file. The Paired Samples t-test was implemented in order to answer the second research question due to the fact that this type of statistical analysis allows the automated calculation of scores based on two samples. For instance, total scores on technical vocabulary pre-task were compared with their paired samples t-test on post-task scores. This statistical analysis was conducted for the technical and sub-technical vocabulary separately and the findings of this analysis are reported in sections 4.3.1-4.3.4.

3.10 Examining the Productive Use of Technical and Sub-technical Vocabulary

Another significant part of this thesis relates to the analysis of medical students' profiling of the degree of technical and sub-technical vocabulary use in their written production. Part of this analysis aims to provide answers to the third research question (see section 1.4). In order to answer it, an appropriate task was necessary in order to assess the degree of technical and sub-technical vocabulary that subjects were capable of using in writing. Different measurement methods were considered and they are more extensively discussed in Appendix ii.

3.10.1 Productive Tasks Data collection

Participating subjects' authentic texts were collected at the end of their academic semester in the form of written assignments submitted for the purposes of their assessment in the institution where the present study took place. The submitted assignments had the same topic and similar length for all 115 participants. In addition, medical students were encouraged to use their readings from sources as well as appropriate presentation of information both in terms of structure and language. Subjects were encouraged to utilize appropriate scientific vocabulary in order to achieve higher marks, thus, they were motivated by the faculty instructors to produce as much technical and sub-technical vocabulary of their discipline in their writing as possible (see Appendix A for grade descriptions). The productive essays aimed at communicating medical information to individuals and interested academics with medical background. Consent was obtained from all participants by means of reading the Participant Information Sheet (PIS) and signing the consent form (see section 3.11.2). All productive tasks were supplied to the researcher by the faculty and they were safely stored in a password-protected computer.

3.10.2 Ethical Considerations for the Productive Task

In order to conduct an analysis on participants' lexical profiles ethical considerations such as permission from the Faculty of Medicine, where the participating subjects submitted their written essay was acquired. Both technical and sub-technical vocabulary were studied based on the same sample population. For the purposes of this study, participants' data was anonymized and no personal details were collected. Essays were obtained and stored in a password-protected computer with their unique ID number. This made it possible to track and match them with the completed pre-task and post-task data.

3.10.3 The Medical Productive (MEDPRO) Corpus Analysis

As discussed in section 3.10.2, the present study examined the productive vocabulary by means of compiling participants' academic essays. A total of 115 academic essays were compiled on the Medical Productive vocabulary (MEDPRO) corpus and the size of each sample was similar (approximately 1,500 running *words). In addition, the corpus was balanced in terms of consistency in length and topic. This goes in line with the follow-up corpus comparison between the MEDPRO and the BNC1-BNC25 in line with the specifications outlined by Nation et al. (2016), which recommended a consistent length per written task in order to achieve balance by enhancing comparisons between student writings (see section 2.9.4). The size of the MEDPRO corpus was 209,160 running words, which was appropriate to satisfy the purposes of the present study (McEnery et al., 2006). It should be mentioned here that medical students submitted their academic essays by the end of their first semester of medical studies. All 115 participants who submitted their academic essay for the purposes of the present study took the same course, they followed the same guidelines and utilised the same LETERs and platforms for researching academic references. This had an impact on the representatives of the MEDREC corpus since it appears that all produced tasks discussed the same topic and they were authored by students who used the same learning materials to gain their subject knowledge and produced their academic essays under similar conditions.*

As far as the corpus analysis software is concerned, the present study utilized the online features of the RANGE software (Heatley and Nation, 2002) named: Compleat VocabProfile or VP (Cobb, 2016; Cobb, 2021). The VP platform was first released in 2001 by Tom Cobb and over the years it went through some modifications; at the time of the present research study, version V3 was used. The optimized V3 version could process a minimum of 1500 words per second. Although corpora have been criticized for potentially lacking insights and critical appraisal of the data (Baker and Lebov (2015); McEnery and Gabrielatos (2006), it can be made possible to examine the statistical profile of used vocabulary in the written mode. Specifically, one of its potentials was to examine the vocabulary profile of essays written by learners of English as a foreign language by means of quantifying participants' vocabulary size by comparing (mirroring) it with established wordlists. This corpus analysis tool operates on a textual input that can be typed, pasted or uploaded. It can process quick and efficient corpus comparisons of selected texts with already established wordlists such as: the General Service List (GSL) based on 2284 words (Bauman and Culligan, 1995); the Brown Corpus list based on one million words (Francis and Kucera, 1982); the Academic Word List (AWL) of 570 words established by Coxhead (2000) and the British National Corpus (BNC) list based on one hundred million words (BNC, *2007). Cobb's website provides a useful platform for lexical analysis and it is updated with new wordlists frequently. Booth (2021a) claimed that the VP is the most up-to-date and the most rigorous tool of its kind.*

As a research tool, Cobb's (2016) VP was utilised for research in order to evaluate participants' productive writing. For instance, Coniam (1999) utilised the VP or LFP in order to evaluate the type of vocabulary used in texts written by 13 participants of Chinese L1 suggesting that more frequently occurring vocabulary was utilized by weaker learners of English, while the less frequent vocabulary was utilized by advanced learners. Moreover, Laufer (1994) used the same research tool in order to find similarities and differences on the kind(s) of vocabulary used by undergraduate participants of English at different periods of their studies suggesting the effectiveness of vocabulary instruction over incidental learning. Moreover, Surtees and Horst (2013) utilized the VP to investigate the type of vocabulary encountered in English webpages of Canadian Universities concluding that the type of vocabulary encountered is beyond the 2K most frequent words appearing in the BNC. Thereby, it was suggested that a wordlist might be necessary in order to be used for learning and teaching purposes especially for participants of English as a second/foreign language who intend to apply to English-speaking universities in Canada. Furthermore, Lin (2015) utilized the VP in order to generate lexical profiles to investigate the relationship between lexical depth and participants' proficiency of 150 Chinese participants concluding that depth in association with breadth can be an effective estimate of participants' degree of proficiency in English. Moreover, Shone (2015) utilized the VP in order to examine the appropriacy of Graded Readers for participants of different levels concluding that they are an appropriate means to teaching vocabulary. Recent research such as Michel and Plumb (2019) and Hamada (2020) and Booth (2021b) was based on the VP to assess productive vocabulary and compare the VP findings with the receptive vocabulary in line with the purposes of the present study. The research studies that utilized the VP made it clear that it can be a very useful tool for corpus analysis research. It is also easy to access, it provides rigorous and accurate results and it is freely available for pedagogical and research purposes. Thus far, Cobb's VP has been utilized to mirror the degree of sophistication of lexical items that appear in student essays with established wordlists such as the BNC, which were utilised as a point of reference of sub-technical and technical vocabulary in the present study (see section 3.6.4).

However, the VP has received scepticism from researchers who pointed at the weaknesses of this tool such as the fact that it processes texts over 200 words and but not shorter (Laufer and Nation, 1995) and cannot compare multiple sample files at once. An alternative option such as the AntWordProfiler (Anthony, 2022) was available at the time of the present research. Both the Antword profiler as well as VocabProfiler have the capacity to conduct mirror corpus analysis efficiently and effectively and they were considered as highly reliable tools. In the context of utilizing the BNC as a mirror corpus, both software were highly efficient in terms of text comparison. The selection of VocabProfiler over AntwordProfiler is multifaceted and relates to the reason why the Range software was not selected to carry out the MEDPRO analysis. Specifically, the AntwordProfiler, the Range and the VocabProfiler were fast and free corpus analysis tools available for public use. However, in order to conduct the mirror corpus analysis, the AntwordProfiler and the Range needed downloading and manual entry of wordlists while the VocabProfiler could execute the analysis online with already built in wordlists. In addition, the AntwordProfiler and Range input methods were through saved texts in .txt format, which means that additional time and effort would be necessary to conduct the format conversions and save the files, while the Lextutor was operating in both .txt and .doc/.docx as well as text/copy-paste options. In addition to this, word tokens, text coverage, bar charts and colour coding texts were not featured in the AntWordProfiler, while the VocabProfiler could perform these features, which were important for the present study. In the past, any reliability issues with the Vocabulary Profiler stemmed from potential changes in the wordlists it uses to run the corpus analysis. The wordlists have been stable for many years, which helps maintain consistency in findings. A limitation that is worthy of mention relates to internet connection speeds may result in variations in findings with a partial output. This was not a problem in the context of the present study as the speed of the internet connection was very fast, which enabled the VocabProfiler to run properly. As mentioned in sections 2.9.1 and 2.9.3, both tokens and lexical coverage were looked at in this study and the charts and colour coded texts, although they were not used directly in this study, they were helpful in order to get visual representations of the mirror corpus analysis for each essay output. It appears that both corpus analysis options offered very similar features and had the potential to conduct corpus analysis in a reliable and valid manner and one of the two options, the VocabProfiler was preferred due to its' user-friendliness. It *appears that the weaknesses of the VP were minimal in the context of the present study given that texts of more than 200 words were uploaded for the corpus comparison and each of the 115 files was analysed separately.*

Booth (2021a) suggested that vocabulary in writing can be sophisticated and rich at analysing vocabulary that belongs to different levels and its' degree of complexity can be evaluated by means of utilizing extrinsic methods such as the VP analysis. The VP involves mirroring the produced vocabulary with established wordlists such as the BNC (see section 2.9.4). Upon mirroring, it can be possible to observe in which word category the produced vocabulary belongs to, thus making inferences regarding the proportion of technical and sub-technical vocabulary included in it.

Thus, for the purposes of the present study the VP was selected for the analysis of the MEDPRO due to its user-friendliness (Cobb, 2010) and automated processing of corpus statistics that it generates and its' capacity to conduct corpus comparisons with established wordlists such as the BNC. The VP option BNC-25 can accurately compare the extent to which wordlists ranging between BNC1-BNC25 and off-list are represented in corpus data and corpus statistics based on this comparison. The 25 BNC levels can be understood as elements of lexical frequency reference; each BNC level represents one thousand word families. The lower the BNC level, the more frequent the vocabulary is in the BNC and, similarly, the higher the BNC level the less frequent the vocabulary. For the purposes of analysis of the textual data for the present study, the BNC1-BNC25 and off-lists were considered.

In the case of first year medical students, their submitted essays at the end of the academic term in combination with a sample of evidence-based data produced by participating medical students was necessary. For the purposes of the MEDPRO investigation, each written essay was examined separately by means of running the VP and corpus statistics were conducted on SPSS in order to generate the findings of this study (see section 4.4). The exact number of lexical items mirrored in the essay is documented in detail along with a percentage of appearance within the text in the VP output (see Appendix V) and findings based on it are reported in section 4.4.1.

3.10.4 Data entry

Upon acquiring the participants' 115 academic essays, a matching procedure was performed in order to avoid random inclusion of essays in the research study. To illustrate, participating subjects who took both the pre-task and post-task were identified by their ID number, which means that the matched pre-tasks, post-tasks and academic essays were submitted by the same individuals. Their respective productive task, which was an essay written and submitted by the participants, was downloaded from a secure repository for the purposes of this study and stored in a password protected computer that only the researcher had access to.

3.10.5 Data Normalization Process

The MEDPRO normalization process was administered in a similar way as the MEDREC (see section 3.3.1) and it was a pivotal part of the corpus preparation in an attempt to make the corpus software run more efficiently. Specifically, all texts underwent a manual editing process in line with Laufer and Nation (1995) propositions, which included removing punctuation marks, abbreviations, numbers and list of references was excluded. Instead, the main essay texts were selected because they reflected participants' efforts to write by means of using the vocabulary of their discipline in order to engage with their subject-specific topic that would contribute towards their academic evaluation. Thus, individual essay texts of the Medical Productive corpus (MEDPRO), which consisted of 115 essays and 209,160 running words were ran on the VP as separate files.

3.10.6 Vocabulary Profile (VP) Output Data Interpretation and Analysis

The VP output classified word items appearing in medical texts into 25 BNC lists including an off-list for vocabulary that was not included on the BNC. The MEDPRO corpus was expressed in BNC types/tokens ratio, in percentage and word families count offering the option to to examine which of the BNC lists were mirrored in each analysis. The BNC was selected as the comparison corpus based on the rationale that it incorporates a large variety of real and purposeful use of language in English (see section 2.9.4). For the purposes of this study, the

BNC and its 25K wordlists would be used as a point of reference since different lists of words signify different frequency of usage in oral or written English conversations. The BNC has already been used for the analysis of technical and sub-technical vocabulary appearing in the MEDREC corpus in the present study (see section 2.9). Specifically, a distinction was made between the technical and sub-technical vocabulary depending on the reflection of BNC word items on the MEDREC. A similar process to the MEDREC was followed to determine the technical and sub-technical vocabulary included on the MEDPRO (see section 3.6.4).

Specifically, for the investigation of technical and sub-technical vocabulary appearing in medical essay texts, BNC4-BNC25 and off-lists were part of the data analysis of the present study. Following the framework implemented by Hsu's (2013; 2018) studies on medical text corpora and Schmitt and Schmitt (2014), BNC1-BNC3 was classified as General English. Although it has been claimed by Coxhead and Demecheleer (2018) that some General English words often have various degrees of technicality, this would be a legitimate argument to consider if the present study was looking at vocabulary depth. Since this investigation is geared towards vocabulary size, it goes beyond the scope of the present thesis to look into the technicality of general vocabulary, which can make the exclusion of BNC1-BNC3 from the analysis a reasonable one. Then, in line with Hsu (2013; 2018), the BNC4-BNC14 was classified as sub-technical English given that it represents the grey area between general and technical vocabulary. Finally, the BNC15-Off-list was considered as technical vocabulary with rare and unused technical items or jargon that is not encountered in General English conversations often (Hsu, 2013). The identification process of technical and sub-technical vocabulary was discussed more in depth in sections 2.9 and 3.5.4.

3.10.7 The MEDPRO Data Analysis Process

As mentioned in the previous section 3.10.6, data from the MEDPRO corpus was analysed on the Vocabulary Profiler (VP). Each essay of the MEDPRO corpus was run individually and each learner profile analysis output was stored in a single Excel file. Automated corpus statistics that was beyond the focus of the present study were omitted and focus was placed on the BNC corpus comparison data. Specifically, the colour coded word items were indicative of the BNC frequency *that each word belonged to as well as the off-lists. In addition, visuals were generated for each profile. From the corpus statistics output, BNC1-BNC3 was eliminated due to its' association with General English vocabulary in line with Hsu (2013; 2018) and Schmitt and Schmitt (2014) (for further elaboration on this see section 3.6.4). The results were then transferred into a new excel sheet, where a further distinction between technical and sub-technical vocabulary tokens was made. To be more precise, upon excluding the BNC1- BNC3 from this study, the BNC4-BNC14 was identified as sub-technical vocabulary following Hsu (2014) and Nation's (2006) suggestion that 99% of text coverage can be achieved solely with awareness of the first K14 wordlists given that the more specialized items of the discipline would appear in higher levels of vocabulary frequency. In addition, the BNC15-BNC25 as well as the off-lists were classed as technical due to their belonging to rare and specialized technical vocabulary, as discussed in section 3.11.6. This classification of word items contrasts Ripamonti (2015) who classed any vocabulary item ranging above BNC4 including off-list items as technical vocabulary without acknowledging the presence of sub-technical vocabulary in her findings. The present study aims to support and provide further evidence-based data by means of following Nation's (2006), Hsu (2013) and Schmitt and Schmitt (2014) framework for implementation of the BNC lists for identifying sub-technical and technical vocabulary.*

Upon analysing the corpus statistics data that emerged from each of the 115 productive tasks of technical and sub-technical lexical items, numerical calculations were performed to produce total scores for technical and sub-technical vocabulary per analysed essay output. Finally, all scores were transferred into an SPSSV24 file for further statistical evaluation and analysis and findings are reported in sections 4.4 and 4.4.1.

3.11 The L1 and L2 Variables

In order to answer the fourth research question of the present study (see section 1.4), the participating subjects' receptive and productive data was further analysed based on the linguistic background of the respondents.

Specifically, the samples SPSS dataset was further split into two datasets for each of the two groups concerned (L1/L2). Given that much of the data and *methodology procedures were implemented for the analysis of the entire dataset; the same processes was repeated for the analysis of L1 and L2 subjects in a split dataset. To analyse receptive recognition, the process outlined for the analysis of the RecRec tasks scores is outlined in section 3.8 for the L1 and L2 dataset separately. In addition, the already analysed texts of the MEDPRO were split for the purposes of answering the fourth research question and the process outlined in section 3.10.7 for the analysis of the MEDPRO data was generated for the L1 and L2 subjects separately. Findings on the fourth research question are documented in section 4.5 and 4.6.*

3.12 Conclusion

This chapter presented the methodological procedures that took place in order to answer the four research questions that the present study looks at. Specifically, it discussed the generation of MEDREC corpus from the LETERs available and the textual data that were sampled for the purposes of the present study were limited to the period of one academic semester owing to the high volume of data. Then, the RecRec task design procedure was described in section 3.6.7 in line with a series of decisions that were taken in order to establish reliability and validity of the receptive recognition (RecRec) task. This is because it is the first time that the RecRec task was utilised in research. Thus, the sections included in this chapter discussed the conduct of the pre-task and post-task (section 3.9), data entry and marking process along with a detailed justification of the selection of the algorithm to mark the word recognition tasks (see section 3.7.1 and Appendix T). Another part of this chapter aims to respond to the third research question, which relates to the kind of vocabulary that medical students preferred to utilise productively in their written essays. More specifically, medical students' samples of written production were entered into the VP, a textual corpus analysis tool, and was analysed in terms of the kind of vocabulary. This was achieved by generating the MEDPRO corpus and later classified it on the basis of technical or sub-technical vocabulary (see section 3.10.7). Medical students' submitted academic essays became an empowering tool for the examination of their productive usage of technical and sub-technical vocabulary and the VPs were considered as an appropriate text analysis tool for the purposes of the present study. In addition, the authentic data collected on the MEDPRO was analyzed by means of utilizing the VPs and corpus comparisons were conducted with already established *corpora such as the BNC (see section 2.9.4). Moreover, it discussed the way data was analyzed in order to examine the potential differences in performance between L1 and L2 subjects in section 3.12. Finally, the granting of ethical approval from the faculty as well as consent for accessing medical learning and teaching resources (LETERs), participating in the RecRec task and utilizing the productive academic essay for the purposes of the present study from the participants was discussed in sections 3.7 and 3.11.2. Findings from the methodological approaches outlined in the present section are reported in the following chapter.*

Chapter 4 Findings of the study

4.1 Introduction

This chapter aims to report the findings of this study based on evidence from 115 participating subjects who studied medicine in the year of 2015. It begins by documenting findings of this study from corpus analysis implemented in order to examine the lexical density of technical and sub-technical vocabulary in written texts that medical students confirmed that they used (LETERs). Then, it goes on to analyse the findings from the Receptive Recognition (RecRec) pre-task and post-task for both technical and sub-technical vocabulary. Subsequently, it brings findings on medical students' proportion of technical and sub-technical vocabulary from their academic writing texts (productive task). Finally, it discusses findings on receptive and productive vocabulary for both L1 and L2 subjects. The discussion that follows in this chapter intends to seek answers to the research questions outlined in section 1.4.

As discussed in Chapter 3, the present research is an inter-disciplinary study based on corpora research and analysis that aim to shed light on the technical and sub-technical vocabulary appearing in medical discourse. In addition, it looks into the degree of medical students' receptive and productive vocabulary as well as the impact of first language on the findings. By investigating the two types of vocabulary from multiple perspectives, it was possible for the researcher to gain a better understanding of the topic as well as the degree of challenge that medical texts present to medical students at the beginning of their academic studies.

4.2 Technical and Sub-technical Vocabulary in LETERs

This section intends to present the result of the first research question (see section 1.4). As discussed in sections 2.7 and 2.8, technical vocabulary tends to be specific for each discipline while the sub-technical vocabulary tends to be shared amongst a number of disciplines. The areas between which words constitute technical or sub-technical vocabulary may be challenging to operationalize given that medicine is a science that evolves and develops over *time and new word items may be added in either category or move from one category to another. In the context of the present study, sub-technical word items differ from the technical word items because they tend to be shared between the BNC4-BNC14 and the compiled corpora (i.e. the MEDREC/MEDPRO corpus), as discussed in section 3.6.4.*

Table 13: Illustration of Lexical Density Profiling of LETERs on General, Sub-technical and Technical Vocabulary.

Lexical Density Profiles on Learning and Teaching Materials							
	Tutorials	e-learning	PIPs	PPTs	Textbooks	Computer Practicals	TOTAL
General English Vocabulary	0.58	0.57	0.43	0.35	0.43	0.05	0.397
Sub-technical Vocabulary	0.26	0.2	0.48	0.19	0.2	0.02	0.229
Technical Vocabulary	0.16	0.23	0.09	0.46	0.37	0.93	0.374

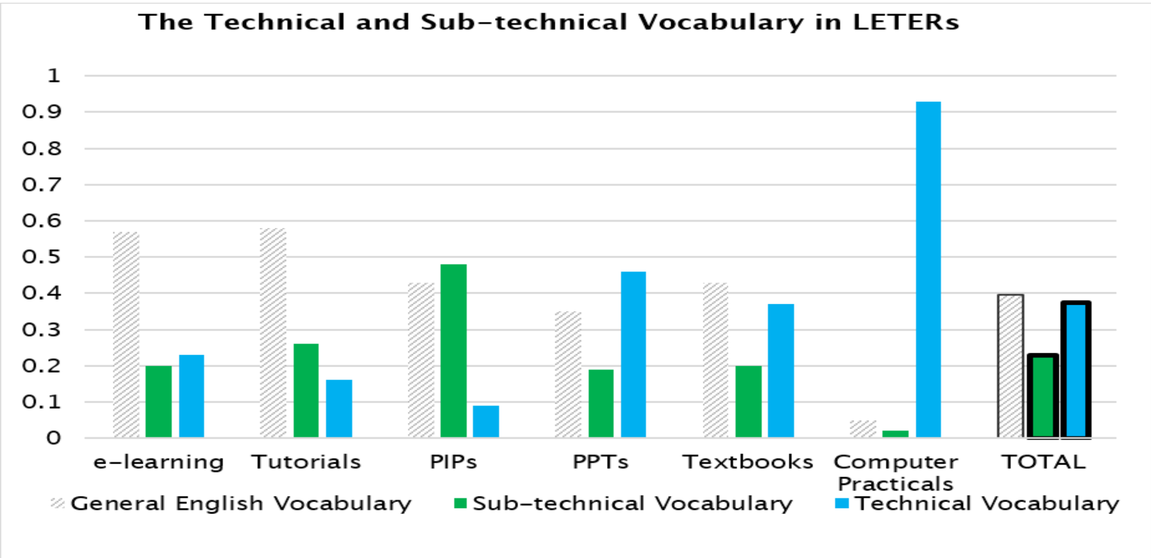


Figure 1: Density Proportions of Technical and Sub-technical Vocabulary in Learning and Teaching Resources (LETERs).

The findings discussed in this section emerged as a result of employing the methodology discussed in section 3.5, which involved the conduct of corpus comparison (mirroring) to generate the lexical density of the LETERs. Upon conducting the lexical density of the LETERs on the RANGE software, lexical data was further analysed in terms of technical and sub-technical vocabulary (see section 3.6.4), while the General English tokens were excluded for the purposes of the present study, as discussed in sections 3.6 and 3.6.4. Interestingly, technical vocabulary was significantly denser in LETERs compared to the sub-technical vocabulary. The differences in lexical density percentages between technical and sub-technical vocabulary are presented in Table 13, Figure 1 and discussed in sections 4.2.1 and 4.2.2 that follow.

4.2.1 Lexical Density in Learning and Teaching Materials (LETERs)

The first aim of the present thesis is to examine the lexical density of LETERs that participants utilized during their initial semester of academic studies. In order to answer the first research question (see section 1.4), it was considered necessary to profile all LETERs both separately and as a whole and look for the degree of density of technical and sub-technical vocabulary in them, as discussed in sections 4.2.1.1 and 4.2.1.2. In addition, in order to ensure that medical students' actually used the LETERs, a mini questionnaire was offered to them in the form of a ranking task at the end of the term asking participants to rate their preferences as regards to the LETERs they used, which were available at the time of the data collection (see section 4.2.2).

4.2.1.1 Technical Vocabulary in LETERs

It can be seen from Table 13, that the majority of the LETERs documented in this study seem to present a higher level of general and technical vocabulary compared to sub-technical vocabulary. In addition, Table 13 is revealing in many ways. Specifically, technical vocabulary is particularly elevated in some LETERs such as: the PPTs, textbooks and Computer Practicals (Scalpel) (see sections 3.3-3.4.5).

Specifically, the three resources with the highest density in terms of technical vocabulary were: the textbooks, lecture slides and computer practicals. Findings *from the present study suggest that medical textbooks and Computer practicals were heavily loaded with technical vocabulary, thus, increasing the lexical demands during the reading process. This is because textbooks and computer practicals reading process is a one-way means of communication as medical students cannot ask questions for clarification to the author. On the other hand, the lecture slides were found to have increased lexical density, however, they were introduced to students during lectures and medical students could take opportunities to request clarifications and elaborations on the information provided in lecture slides. This finding is useful in that it suggests that a large number of technical vocabulary that appears through lecture slides (PPTs) suggests that a great extent of technical vocabulary was introduced in lectures that medical students attended. Thus, there were more chances to familiarize with technical vocabulary in lectures designed and delivered by experts in their fields (see section 3.8 for further elaborations).*

Overall, it can be seen in Table 8 that the lexical density percentage of technical vocabulary appearing in LETERs is 0.46 (or 46%), suggesting that nearly half of the vocabulary presented in lecture slides is technical. Similarly, the recommended textbook resources that were available to medical students included 0.37 (or 37%) of technical vocabulary in them, which is significant. In addition, the lexical density percentage of technical vocabulary in computer practicals reached 0.93 (or 93%). This evidently high percentage of technical vocabulary density can be explained on the basis that computer practicals were authentic texts from original clinical cases involving students in interactive Problem Based Learning (PBL). Finally, textbooks density of technical vocabulary was significantly lower compared to computer practicals (textbooks technical vocabulary density = 37%), which is indicative of the adapted and edited nature of textbooks that are informative yet they lack the degree of authenticity that computer practical resources offer.

4.2.1.2 The Sub-technical Vocabulary in LETERs

When sub-technical vocabulary was examined in LETERs, a lower lexical density percentage was observed. Specifically, it can be seen in Table 13 that on average sub-technical vocabulary represented 20% of the LETERs with the exception of the PiPs with 0.48% (48%) and tutorials with 0.26 (26%). sub-technical vocabulary had *higher degrees of sub-technical vocabulary density. One reason that could justify this finding might be the fact that both resources had a supplementary role and aimed to reinforce and consolidate a selection of concepts previously introduced in lecture slides or textbooks (for a review of the LETERs resources, see sections 3.3-3.4.5). Given that both the PiPs and tutorial notes were supplementary and did not aim to provide new medical knowledge but aimed to put it to practice, they included activities (see sections 3.3-3.4.5). The activities were non-mandatory and their aim was to help medical students consolidate key concepts, introduced in lectures. It is possible that by adopting a more accessible vocabulary the PiPs and tutorial notes would have encouraged medical students to utilize them more extensively.*

In addition, it is worth mentioning that the only resource that provides a balance of the two types of vocabulary investigated: the technical and sub-technical was the e-learning resource. Findings suggest that the lexical density of sub-technical vocabulary was 0.20 while the lexical density of technical vocabulary was slightly higher (0.23). As e-learning materials were meant to be used independently, it seems that they had the potential to introduce medical students to a balanced range of technical and sub-technical vocabulary during students' personal study time.

Thus far, it is documented in this section that both technical and sub-technical vocabulary had a high lexical density in two sources out of the five LETERs investigated and a balanced density has been observed in one of them. In addition, density analysis of the entire corpus suggests that, statistically, technical vocabulary is denser in LETERs compared to sub-technical vocabulary, as seen in Table 13.

4.2.2 LETERs' Usage

As discussed in the methodology chapter (see section 3.5.1), medical students who took part in the present study confirmed their usage of LETERs resources during the semester by ranking them in terms of preference (see Appendix Y). Lack of such confirmation would lead to different interpretations of the data. Given that medical students confirmed usage of LETERs texts, findings from the Receptive Recognition (RecRec) task can be better analysed and understood on the basis that medical students did encounter the vocabulary included in the RecRec *task, thus, generating more robust findings and enhancing reliability (see sections 4.2, 4.2.1 and 4.2.2).*

Data from the questionnaire was collected and analysed on SPSS V24. In addition, it was found that medical students utilized all resources available from the faculty, as seen on Table 14. In addition, descriptive statistics suggest that most subjects preferred to utilise their LETERs as illustrated in Table 14 starting from Rank 1 (relied on it heavily) to Rank 7 (didn't rely or didn't use at all). The rank order is a clearer representation of the mean statistics result and is provided in Table 14 below.

Table 14: Ranking of Medical Resources Usage.

Rank	Student Ranking of LETERs Usage	Mean
1st	Medical Lecture Slides (PPTs)	1.39
2nd	Medical Pathology Interactive Practicals (PiPs)	2.24
3rd	Medical Textbooks	3.42
4th	Medical Computer Practicals (SCALPEL)	4.37
5th	Tutorials	4.83
6th	e-learning	5.13
7th	Other Sources	6.71

It appears from Table 14 that participating subjects relied on all LETERs available to them from the Faculty to a different degree. Specifically, findings suggest that the most preferable LETERs were medical lecturers' slides (PPTs) followed by the Pathology Interactive Practicals (PiPs) and medical textbooks. This finding follows previous results presented on Table 13 from the questionnaire on LETERs suggesting that medical students did rely on the LETERs available in different degrees. Data suggest that most medical students relied heavily on lecturers' presentation slides, which, as illustrated in Table 13, they were highly dense in terms of technical vocabulary usage (46%). It seems that the majority of the respondents relied on lecture slides for their study of medical knowledge of all six resources profiled. One reason for this might be that lecture slides were introduced to participants during lectures, which the majority of the participants attended. During lectures, they were given a chance to increase their understanding of technical vocabulary by means of explanations or questions made medical instructors; thereby, they might have been more familiar to *participants. Thus, it is possible that because lecture slides focused on the learning goals set by the faculty and the General Medical Council, thus, they clearly reflected how deep scientific knowledge was expected of them in order to prepare for their exams adequately. This could possibly explain the students' high ranking of lecture slides and a further evaluation will be provided in section 5.4.*

4.3 Receptive Vocabulary: Data Analysis

This study set out to investigate students' receptive recognition of two kinds of vocabulary that typically appear in medicine: the technical and the sub-technical vocabulary. This section aims to illuminate the statistical findings implemented in order to find answers to the second research question that this study is concentrated upon (see section 1.4). In order to answer the second research question, all LETERs available to participants were compiled into a corpus and a representative sample was selected in order to design the Receptive Recognition (RecRec) task (pre-task) and (post-task) (as discussed in section 3.6). The RecRec pre-task was distributed to 115 participants at the beginning of the semester requesting them to tick on vocabulary they recognise and a similar procedure was repeated at the end of the semester (see sections 3.5.8 and 3.8).

In order to analyse statistically the RecRec pre-task and post-task responses, the SPSS V24 package was selected to perform statistical analysis at the time of the research since it had the capacity to generate accurate and sophisticated findings. Prior to the SPSS analysis, the pre-tasks and post-tasks underwent a process of entry and score calculation based on the number of known words and the number of false alarms (FA) (see section 3.7 and 3.11.4). Both the pre-task and post task reflected 8 vocabulary bands which were representative of 5% degrees of lexical coverage each in medical texts during the first semester covering 60%-99% of the corpus (for further elaboration on the concept of lexical coverage see sections 2.4 and 2.6). The 8 lexical bands were designed to assist this investigation by means of classifying the findings on the basis of participants' ability to recognise their disciplinary vocabulary belonging to a number of bands of lexical coverage. This is because vocabulary that represents different degrees of lexical coverage can be extrapolated in order to make estimations on the degree of lexical coverage that participants are capable of recognising when encountered with a written text at the beginning and end of *their initial academic term. In order to observe the participants' recognition of vocabulary on a 5%-level band, lexical items that were representative of the 8 lexical bands were selected for the design of the pre-task and post-task (see Table 10). A total of 10 words from each lexical band were included in the word recognition task as discussed in section 3.6.8.*

Analysis of participants' performance on each of the eight bands of lexical coverage provides insights as regards to the degree of their capacity to recognise vocabulary that belongs to each of the 8 bands, which cover 60-99% of the MEDREC. To this end, Paired Samples t-tests were selected as the primary means of statistical data analysis because it allowed the researcher to observe the overall tendencies of both technical and sub-technical vocabulary separately on lexical recognition. In addition, it could generate comparisons between previous and latter performance for each of the 8 lexical bands. Due to the fact that the output of the statistical analyses that have been carried out appears in decimal form, it was considered as ideal to maintain the original output form as they were produced and tabulated by the SPSS statistics software.

4.3.1 Statistical Findings from the Receptive Recognition (RecRec) Task on the Sub-technical Vocabulary Pre-tasks and Post-tasks

In order to study the participants' performance on the sub-technical vocabulary for both pre-task and post-task, a quantitative approach was employed by means of utilizing the SPSS v24 statistics package since it allows opportunities for conducting comparisons between two strata and makes it possible to observe statistically significant relationships.

Pre-task and post-task scores were analysed statistically by means of employing the paired samples t-test for the sub-technical vocabulary included in the RecRec task amongst the whole cohort. As can be seen in Table 15, the mean score of the pre-task was .6388 and the post-task score was .7813 (see Table 15). This suggests that the average candidate entering the faculty of Medicine where the study took place was capable of recognising more than half of the sub-technical vocabulary introduced in LETERs but not all. In addition, post task scores reveal that their capacity to recognise the sub-technical vocabulary of their discipline had increased by .14254, which indicates a greater expansion of their vocabulary *skills in recognising the sub-technical vocabulary of their discipline during the period of one academic semester. Furthermore, the p-value was p<.001 (Table 15) indicating that this improvement in scores is statistically significant on the 5% level. In addition, the standard deviation on the post-task is .15895, which is significantly higher compared to the pre-task. The higher degree of standard deviation on the post-task suggests that participants' responses by the end of the academic semester seemed to have a greater variability in terms of scoring compared to their responses on the pre-task. Based on this ground, it is evident that participants' degree of recognition of receptive sub-technical vocabulary had greater inconsistencies between participants by the end of their first semester of medical studies suggesting that each individual developed their awareness of sub-technical vocabulary at a different pace throughout the semester.*

Table 15: Findings from Paired Samples Statistics on Sub-technical Vocabulary (RecRec) pre-tasks and post-tasks.

Paired Samples: Sub-technical vocabulary						
		N	Mean	Std. Deviation	Mean Difference	p-value
Sub-technical Vocabulary	Pre-task	115	.64	.15	-.14	.000
	Post-task	115	.78	.16		

Thus far, results from paired samples t-tests have been reported suggesting an overall increase in sub-technical vocabulary over the period of one academic semester. In order to explore further students' performance on the 8 bands of lexical coverage of the sub-technical vocabulary reflected on the RecRec Task, paired samples t-test analysis was conducted to examine participants' scores in each band (see section 4.3.2).

4.3.2 Sub-technical Vocabulary: Lexical Bands Analysis

Similarly to the process followed in order to investigate the overall scores on sub-technical vocabulary (see section 4.3.1), the paired samples statistical analysis was employed for the comparison of pre-task and post-task performance for each band of lexical coverage for technical and sub-technical vocabulary separately.

As mentioned in section 3.6.3, the proposition of the reverse principle of lexical coverage was employed for the purposes of the present study as a parameter that could assist with the extrapolation of participants expected familiarity from the pre-task and post-task findings. As discussed in section 2.9.3, a higher percentage of recognised lexical coverage is indicative of a higher capacity to recognise vocabulary that belongs to it receptively. Thus, the higher scores on each sub-technical vocabulary band represented on the RecRec, the higher the students' ability to recognize vocabulary from the degrees of lexical coverage they represent (see section 3.6.3).

Table 16 shows the pre-task and post-task responses for each band of lexical coverage represented on the RecRec pre-task and post-task. Results from the paired samples analysis indicate that the first lexical band (Band 1), which represents 60-64% of lexical coverage in LETERs, produced similar scores in both pre-task (.7764) and post-task (.7797) and had no statistically significant scores as sig. (2-tailed) = .874. This finding from Band 1 suggests that familiarity with the word form of Band 1 vocabulary items such as: atoms, angina and obesity was similar at the beginning and end of the first academic semester.

A similar pattern was observed in responses belonging to the second band (Band 2) of sub-technical vocabulary, which ranged from 65%-69% of lexical coverage in LETERs. When participants were asked to recognise sub-technical vocabulary such as nuclei, antimicrobial and anaesthetic on the RecRec, they produced similar scores in both pre-task (.7326) and post-task (.7750). Although there was a slight increase in the post-task scores, they were not statistically significant since sig. (2-tailed) = .036>.005. Similarly to findings in Band 1, the pre-task and post-task scores were consistent in that they had higher scores indicating that students were already familiar with most of the items. Thus, it is highly possible that the majority of the vocabulary items in Band 2 were known to the participating subjects.

However, a different pattern in pre-task and post-tasks scores was observed on the third lexical band (band 3), which represented vocabulary ranging from 70%-74% of lexical coverage and included lexical items such as arteriosclerosis, buccal and cathepsin. Unlike the previous two bands, the mean score of the third band was lower on the pre-task (.3954) and increased significantly on the post-task (.7359). This difference in mean scores on the pre-task and post-task *performance (.34052) was statistically significant with sig. (2-tailed): p<.001. This finding suggests that participants may have not been able to recognise sub-technical vocabulary items of their discipline that belonged to Band 3 at the beginning of the term but have clearly made a substantial progress over the period of one semester of academic studies in medicine.*

In addition, the fourth lexical band (Band 4) of sub-technical vocabulary covers vocabulary items belonging to 75%-79% of the MEDREC corpus' lexical coverage with representative vocabulary items such as cilia, endocytosis and corticosteroids included in the RecRec task. A similar pattern to the previous lexical band (Band 3) has been observed with a lower mean score on the pre-task (.6601) and a higher mean score on the post-task (.8920). The mean difference (.23191) was indicative of an improvement in terms of vocabulary recognition, which was statistically significant with Sig. (2-tailed) = p<.001. At this point, it should be mentioned that a rise on standard deviation was documented on the pre-task (.24527), which rose to .33286 on the post-task, suggesting that there was a greater variability in scores in the post-task. This suggests that medical students had different degrees of positive linguistic development over the period of one academic semester.

The fifth band (Band 5) of sub-technical vocabulary represents 80%-84% of lexical coverage and words that represented this lexical band on the pre-tasks and post-tasks were genomic, bile and homeostasis. The mean score of the pre-task was .6523, while the mean score of the post-task reached to .9149 signifying a mean difference of .26252. This difference was statistically significant as Sig. (2-tailed): p<.001 at the 5% level. In addition, the std deviation was .21761 on the pre-task, while the standard deviation was much higher on the post-task with .32897. This suggests that participants' responses on Band 5 were more diverse on the post-task than on the pre-task. Similarly to lexical Band 4, diversity in response scores indicates that different participants' responses tended to vary much more on the post-task than on the pre-task. This made it evident that subjects' capacity to recognize the sub-technical vocabulary represented in Band 5 varied greatly suggesting some degree of progress for every participating subject.

Furthermore, the sixth band (Band 6) of lexical coverage which represents 85%-89% of lexical coverage in the pre-task and post-task included sub-technical vocabulary items such as allele, encephalopathy and phosphorylated. A similar *trend to the previous lexical bands discussed in this section has been observed. This means that similarly to Band 3-Band 5, Band 6 had a lower mean score on the pre-task (.6168) and higher mean score on the post-task (.8850) with a mean difference of .26817. This finding is statistically significant with sig. (2-tailed): .000 suggesting that respondents appeared to have significantly increased their awareness of this kind of vocabulary over the period of one semester. What is striking, however, is the fact that the standard deviation was higher on the pre-task (.20326) than the post-task (.18429) for this band suggesting that the participants' responses tended to be less diverse on the post-task. It is evident from the finding that the participants' ability to recognise their receptive vocabulary between 85%-89% of lexical coverage in learning and teaching materials was spread more evenly across the entire population of participating subjects. This signifies that students' degree of recognition of sub-technical vocabulary items belonging to 85%-89% of lexical coverage has developed for the majority of participants that were recruited in this study.*

Similar findings have been documented for the seventh lexical band (Band 7), which represents 90%-94% of lexical coverage of sub-technical vocabulary in LETERs. Examples of vocabulary items, which were included in Band 7, were words such as: bilirubin, haematopoietic and atrophic. It has been observed that Band 7 had lower pre-task (.4581) and higher post-task scores (.6137) suggesting an improvement in awareness of this kind of vocabulary by the end of the semester. In addition to this, the mean difference between the pre-task and post-task was .15557 with Sig. (2-tailed) = .000 indicating that the mean difference in results was statistically significant in Band 7. It is evident here that a significant improvement in participants' recognition of their receptive sub-technical vocabulary lexical items representing Band 7 took place by the end of the academic semester. In addition, it is worth mentioning that the standard deviation on the pre-task was .23176, which was much lower than the standard deviation on the post-task (.39447). This indicates that most participants' scores on recognition of receptive vocabulary between 90%-94% were diverse on the sub-technical vocabulary belonging in the 90%-94% of lexical coverage. This finding is meaningful as it implies a relative difference in participants' ability to recognize the vocabulary of this band, which could be attributed to different levels of receptive ability of discipline specific vocabulary.

The last band (Band 8) represented lexical coverage ranging between 95%-99%. It included sub-technical vocabulary items such as histamines, analgesic and melanomas. Interestingly, the mean score on the pre-task (.6133) was at a similar level as the mean score documented on the post-task (.6148) with a low statistical difference (.00148) observed between the tasks, which was of no statistical significance as sig. (2-tailed): .958>.005. In addition to this, the standard deviation of the post-task was .30765 indicating a minimal diversity in scores on the post task. This finding suggests that participants' scores on the RecRec task ranging between 95%-99% of lexical coverage had an average score, which suggests an interesting degree of familiarity (over 60%) with the vocabulary ranging above 95% of lexical coverage. Although the scores were interesting, they did not seem to increase over the period of one semester for the majority of the participating subjects. However, it is important to note that more than half of the vocabulary that belongs in this category seems to be known on the pre-task and on the post-task. This can be indicative that medical students might have achieved over 95% familiarity with their sub-technical vocabulary yet this does not suggest that they effectively managed to recognize vocabulary up to 99% of lexical coverage (fluent reading). Table 16 summarises participants' scores on receptive recognition of sub-technical vocabulary for each of the eight bands of lexical coverage that were included in the pre-task and post-task.

Taken together, the findings reported in this section provide important insights into the second research question that this thesis is looking at suggesting an overall development in terms of receptive recognition of the sub-technical vocabulary. Specifically, there was a significant difference between pre-task and post-task scores on bands 3-7 representing sub-technical vocabulary ranging between 70%-94% of lexical coverage. In addition, these separate investigations on students' performance on the 8 bands of lexical coverage suggest that no significant increase in receptive recognition was detected in bands 1, 2 and 8 representing 60%-69% and 95%-99% of lexical coverage.

Table 16: Findings from Paired Samples Statistics Test Analysis on Sub-technical and Technical Bands of Lexical Coverage.

Paired Samples on n.= 8 lexical bands									
Bands		**Sub-technical vocabulary Analysis**				**Technical vocabulary Analysis**			
		Mean	Std. Deviation	Mean Difference	Sig. (2-tailed)	Mean	Std. Deviation	Mean Difference	Sig. (2-tailed)
Band 1 60%-64%	Pre-task	.7764	.20472	-.00330	.874	.8135	.15821	-.02270	.156
	Post-task	.7797	.19339			.8362	.15388		
Band 2 65%-69%	Pre-task	.7326	.17671	-.04243	.036	.6087	.17453	-.03722	.093
	Post-task	.7750	.16735			.6459	.21742		
Band 3 70%-74%	Pre-task	.3954	.19004	-.34052	.000	.4565	.18797	-.14452	.000
	Post-task	.7359	.12851			.6010	.23620		
Band 4 75%-79%	Pre-task	.6601	.24527	-.23191	.000	.5356	.13434	-.20974	.000
	Post-task	.8920	.33286			.7453	.12343		
Band 5 80%-84%	Pre-task	.6523	.21761	-.26252	.000	.5183	.24627	-.31878	.000
	Post-task	.9149	.32897			.8371	.34594		
Band 6 85%-89%	Pre-task	.6168	.20326	-.26817	.000	.4982	.25302	-.40026	.000
	Post-task	.8850	.18429			.8984	.34103		
Band 7 90%-94%	Pre-task	.4581	.23176	-.15557	.000	.3420	.20744	-.20583	.000
	Post-task	.6137	.39447			.5478	.26996		
Band 8 94%-99%	Pre-task	.6133	.30430	-.00148	.958	.0328	.10234	-.02661	.168
	Post-task	.6148	.30765			.0594	.17175		

Overall, results highlight that medical students' sub-technical vocabulary reached up to and beyond 95% of lexical coverage, however, average scores in many of the lexical bands examined suggest an ongoing need to further improve students' awareness of sub-technical vocabulary in all bands of lexical coverage under *investigation to develop fluency with the sub-technical vocabulary of medicine (see section 2.9.3). Further discussion on findings reported in this section is provided in section 5.5.*

4.3.3 Findings from the Receptive Recognition (RecRec) Task on Technical Vocabulary pre tasks and post tasks

The present section aims to discuss the findings of the pre-tasks and post-tasks on technical vocabulary with the aim to provide an answer to the second research question that this study is looking at (see section 1.4). The statistical analysis for the investigation of the pre-task and post-task scores on the sub-technical vocabulary (see section 4.3.2) was also employed for the investigation of technical vocabulary. To conduct this analysis, the SPSS V24 was utilised and paired samples t-test analysis was run on pre-tasks and post-tasks scores as illustrated in the summative tabulation below (Table 17).

Table 17: Findings from Paired Samples Statistics on Technical (RecRec) pre-tasks and post-tasks.

Paired Samples: Technical vocabulary						
		N	Mean	Std. Deviation	Mean Difference	Sig. (2-tailed)
Technical Vocabulary	Pre-task	115	.4757	.14143	-.17071	.000
	Post-task	115	.6464	.12199		

It is apparent from Table 17 that results obtained from the paired samples t-test analysis reveal an overall statistically significant development. Specifically, there seems to be an overall pattern suggesting significant improvement as participants mean score on the pre-task was 0.4757 and on the post-task it was 0.6464. This suggests that an average candidate entering the medical faculty for the first time would be able to recognise less than half of the technical vocabulary presented in LETERs. Further analysis of the post-task scores reveals that their ability to recognise technical vocabulary receptively had increased by 0.17071 on the post-task (0.6464). This implies that medical students were capable of recognising more than half of the technical vocabulary presented to them by the end of their initial semester of studies. In addition, findings from the paired samples t-test analysis were significant with sig. (2-tailed) = .000 (p-value<.005). This finding is consistent with previous findings on the sub-technical vocabulary *scores documented in section 4.3.2, which also confirmed an increase in the mean scores of the receptive post-task. Despite the apparent increase in both types of vocabulary on the RecRec task, the sub-technical vocabulary scores on the RecRec were higher than the technical, yet the statistical difference between pre-task and post-task performance is higher on technical vocabulary. This pattern will be further explored in section 5.5.*

4.3.4 Technical Vocabulary: Lexical Bands Analysis

A similar analysis to the one discussed in section 4.3.2 was carried out for the eight bands of lexical coverage (Band1-Band8). A t-test analysis was generated in order to observe how students performed on technical vocabulary that belongs to different bands of lexical coverage which follows an in-depth analysis of the sub-technical vocabulary scores (see section 4.3.2). It should be noted here that in the eyes of an untrained individual in medical science, some technical vocabulary may appear sub-technical and vice-versa. Aiming to avoid the subjective bias in the classification of technical and sub-technical lexical items corpora were utilised in line with Hsu (2013), who claimed that using corpora to identify the sub-technical from the technical vocabulary can be achieved accurately and without a medical expert's opinion.

A total of 8 technical vocabulary bands (Band1-Band8) were generated based on the MEDREC corpus representing 60%-99% of lexical coverage in LETERs. It was pointed out in section 3.6.3 that the issue of reverse lexical coverage was key in the generation of receptive vocabulary tasks since it can assist the researcher to make inferences on subjects' awareness of vocabulary that belongs to different degrees of understanding a medical text from LETERs (for further discussion on lexical coverage, see section 2.9.3). Pre-task and post-task scores were analysed with the application of SPSS V24 and the analysis of paired samples t-tests. Table 16 presents the t-test analysis scores for technical vocabulary ranging between Band1-Band8 of lexical coverage.

A t-test analysis of the first lexical band (Band1) involves vocabulary items belonging to the 60%-64% of lexical coverage and included technical vocabulary items such as influenza, peptide and neurons. It appeared from the data that task responses had a mean score of .8135 on the pre-task and .8362 on the post-task. Findings between pre-task and post-task performance on Band1 had no statistical *significance (p-value=0.156, p>.005). This suggests that most participants were capable of recognising the technical vocabulary items that were representative of Band 1 from the beginning of their medical studies.*

A similar finding has been documented on the second band (Band 2), which represents technical vocabulary ranging from 65% to 69% of lexical coverage, and included word items such as: intestinal, endoplasmic and golgi. The mean score achieved on pre-tasks was 0.6087 and it reached to 0.6459 on the post-task (see Table 16). It is evident from the post task scores that there was some degree of improvement in participants' recognition of technical vocabulary in the post-task with a mean difference of 0.03722 (see Table 16). However, it is statistically insignificant as sig (2-tailed) =.093, p>.005 on the 5% level. This finding shows that participants seemed to have a similar level of familiarity with technical vocabulary belonging to Band 2 from the beginning of their studies and it had a minimal improvement by the end of the semester. In addition, the std deviation was positive with a score of .21742, which was higher on the pre-task and lower on the post-task suggesting minimal difference in pre-task and post-task performance on the RecRec for Band 2. Similarly to Band 1, it is possible that students had a previous acquisition of the technical vocabulary of Band 2 prior to their academic studies.

The third band (Band3) included in the pre-task and post-task examined participants' awareness of medical vocabulary belonging to 70%-74% degree of lexical coverage. Examples of vocabulary items representing this band were words such as dendrites, peptoglycan and gonadotropin. What is interesting here is that although participants recognised less than half of the lexical items included in Band3 on the pre-task (0.4565), their performance on the post-task had improved as they reached .6010 with a mean difference of 0.14452 (see table 16). The finding is statistically significant as sig. = .000 and p<.005 and it is clear from the above that there had been some significant development in recognition over the course of one semester of studies. In addition, the post task responses presented higher variability in scoring with std. = .23620, which was higher than the pre-task.

The fourth lexical band (Band4) that was represented in the pre-task and post-task represents 75%-79% of lexical coverage; examples of words belonging to Band4 were: vecuronium, microvilli and ribosomes. It appeared from the data *that participants scored .5356 on the pre-task and .7453 on the post-task with a mean difference of .20974, which is statistically significant with Sig (2-tailed) =.000 on the 5% level. Similarly to Band3, participants appeared to be able to recognise nearly half of the vocabulary at the beginning of the term and managed to make a significant difference over the period of one semester. This difference is evident from participants' higher scores on their receptive post-tasks. In addition, the std. deviation was higher on the pre-task .13434 suggesting that prior to acquiring the technical vocabulary of Band4 learners seemed to have inconsistent scores.*

The fifth band (Band5) of technical vocabulary represented 80%-84% of lexical coverage and examples of words that represented this lexical band were: sacral, pyrimidines and ticarcillin. A significant improvement has been observed with a mean score of .5183 on the pre-task and .8171 on the post task. The mean difference was .31878, which is statistically significant as sig (2-tailed) = .000 with p<.005. In addition to this, it should be mentioned here that the spread in standard deviation on the pre-task was .24627, which is lower compared to the standard deviation on the post-task, which is .34594. This indicates that scores on the post-task were more diverse and spread than on the pre-task. This suggests that participants' degree of recognition of this type of vocabulary was not always similar for all participating subjects suggesting that participants' improvement of their capacity to recognise technical vocabulary between 80%-84% of lexical coverage was quite diverse.

The sixth band (Band6) of technical vocabulary that was included in the receptive recognition task represented vocabulary in the range of 85%-89% of lexical coverage in learning and teaching materials. Examples of Band6 were words such as: clostridium, streptococci and hypoxia. The mean score on the pre-task was .4982, while the mean score on the post task was .8984. The mean difference in score was .40026, which is statistically significant as Sig (2-tailed) =.000. Similarly to the observation documented in the previous band (Band5), the standard deviation on the pre-task was .25302, which is much lower than the standard deviation appearing on the post-task:.34103. Once again, it appears that participants' std scores were .12199 and had an inconsistency that could be explained on the basis that participating subjects had different scores from each *other and, in all probability, a different linguistic development in the technical vocabulary under investigation over a period of one semester of studies.*

The seventh lexical band (Band7) represented vocabulary ranging between 90%-94% of lexical coverage. Examples of this kind of vocabulary are word items such as epitheloid, hepatomegaly and sarcomere. Data show that the mean pre-task score was .3420, while the mean post-task score was .5478. The mean difference was .20583, and the finding is significant as Sig (2-tailed) = .000, p<.005. It is interesting to mention here that scores on the post-task were higher than average, which suggests that approximately half of the words representing 90%-94% of lexical coverage on a given task remained unrecognised by participants by the end of their initial semester of studies. This finding suggests an overall improvement of receptive recognition of technical vocabulary belonging in the range of 90%-94% of lexical coverage. In addition, the standard deviation in the post-task was .26996, while the standard deviation on the pre-task was much lower .20744, which indicates that there must have been a higher variability in score responses on the post-task.

The last band under investigation, Band 8, examined vocabulary that represents the lexical coverage levels between 95%-99%. Examples of vocabulary of this level are words such as moxifloxacin, cyclosporin and splachnic. The mean score on the pre-task was .0328, while the mean score on the post-task was .0594, which suggests a mean difference of .02661. Although medical students achieved a positive difference on this type of vocabulary, the mean difference in the scoring of the two kinds of vocabulary was not found to be statistically significant with sig (2-tailed) = .168, p>.005. In addition, the standard deviation was higher on the post-task, indicative of a wider range of scores for this band. This finding is similar to the finding on the sub-technical vocabulary (see section 4.3.2) as it appears that vocabulary of the 95%-99% of lexical coverage did not seem to be successfully recognised by participants neither on the pre-task nor on the post-task.

This section presented the findings from the analysis of technical vocabulary included in the receptive word recognition (RecRec) task scores. Pre-task and post-task scores for each of the 8 bands of lexical coverage were also analysed. Findings suggest an overall positive improvement of technical vocabulary during medical students' first semester of studies. A similar pattern was observed on *participants' performance on vocabulary belonging to different degrees of lexical coverage. More specifically, the first two lexical bands (Band1 and Band2) representing 60% to 69% of lexical coverage as well as the last band, Band8 (representing 95%-99%), seemed to have no significant progress. On the other hand, there is strong evidence of improvement between Band3-Band7, representing 70%-94% of lexical coverage in terms of participants' receptive capacity for technical vocabulary recognition. This result, although encouraging, it was not indicative of full recognition of all technical word forms examined, suggesting that there is room for future improvement.*

4.4 Findings on Participants' Productive Vocabulary

This section aims to provide an answer to the third research question that this study examines as outlined in section 1.4. In order to assess medical students' written production, 115 samples of academic essays (see section 3.11.1) were collected and profiled and the proportion of both technical and sub-technical vocabulary usage in writing was examined.

4.4.1 Results on Productive Vocabulary: Technical and Sub-technical

This section aims to present findings on the lexical profile of technical and sub-technical vocabulary identified in the Medical Productive (MEDPRO) corpus, which consists of 209,160 running words. Specifically, the MEDPRO was compiled from 115 academic essays written by participating subjects for the purposes of coursework assessment as described in section 3.11.3. Upon profiling each of the 115 academic essays separately and identifying the technical and sub-technical vocabulary, the total sum number that was indicative of the density of technical and sub-technical vocabulary usage in writing for every essay was entered in SPSSv24 and was matched with the participants' pre-task and post-task performance, as discussed in section 3.10.

In order to answer the third research question, a descriptive statistics method was initially implemented in order to get an overall perspective of the degree of usage of technical and sub-technical vocabulary appearing in the MEDPRO corpus in which the unit of counting words for the MEDPRO analysis was word tokens (see section 2.9.1). In addition, the unit of counting words was considered in light *of the investigation of the degree of lexical richness in texts. In the present study, which was conducted in the field of medicine, its' vocabulary often involved specialist lexis and derivatives. Word calculation means such as word families/types/lemmas might have incorporated specialist vocabulary items/forms specific to medicine in them as discussed in section 2.9.1. Specifically, it suggested that studying uncategorized instances of language, for example, in the form of word tokens, could bring into the surface the vocabulary that is specific to medicine. In this way, it can avoid focusing on word units such as headwords that may cover a broader area of word form. For instance, the technical word parasynapticals found in the MEDREC data affixed, could have been potentially classified under the headword: synapse, thus, missing an important component of its authentic form as it appeared in the corpus. In addition, if it had been examined as a word family (synapse); as a word type it would be examined as parasynaptic and as a lemma it would be: parasynaptical. It appears from this example that technical words may miss important derivative forms that focus on the authentic form of a word as it is used in context due to classification constraints. Thus, usage of word tokens was deemed as appropriate in the present study aiming to facilitate precision in data analysis and results. To this end, tokens have been advantageous in contexts where vocabulary is used by members of the same group and can be utilised in order to make it possible to communicate with others accurately and precisely (Nation, 2001). Thus, lexical studies in the field have been conducted using word tokens as a means of measuring vocabulary profile in medical texts (Chung and Nation, 2003). This is because looking into word token form in a text is an indispensable lens through which it can be possible to gain useful insights regarding the richness of vocabulary used in written texts (Laufer and Nation, 1995). In the case of the present study, which focuses on specialised vocabulary used in medical texts, tokens allowed the researcher the possibility to analyse words that could be derivatives or inflected forms from lexical units and study them in their original form as they appeared in the authentic texts.*

Upon running separate analysis for each academic essay on the Vocabulary Profiler (see Appendix ii), and entering a total score of the number of technical and sub-technical vocabulary used in the essay, a data analysis was ran on the SPSS as seen in Table 18. Specifically, the mean score for the sub-technical vocabulary tokens is: mean=178.5, its' mean lexical density in medical texts is

9.45% based on the lexical density calculation suggestion by Halliday (1985) discussed in section 2.9.5. The finding is relatively low, but not lower than the mean technical vocabulary usage, which had a mean score of mean=88 and a lexical density percentage of 4.67% on the MEDPRO corpus. Thus, there seems to be a higher lexical density percentage of sub-technical vocabulary compared to technical vocabulary on the MEDPRO data suggesting that participants' productive vocabulary use included more sub-technical vocabulary tokens than technical (see Table 18).

Table 18: Summary of Lexical Profiles Descriptive Statistics.

Descriptive Statistics Output on Productive Vocabulary Tokens				
	Sub-technical Vocabulary N	Sub-technical Vocabulary %	Technical Vocabulary N	Technical Vocabulary %
Minimum	92	4.87%	17	0.93%
Maximum	265	14.02%	159	8.41%
Mean	178.5	9.45 %	88	4.67%
Std. Deviation	32.33627		29.56068	

The statistical findings presented on Table 18 can be visually summarised on the following scatterplot (Figure 2).

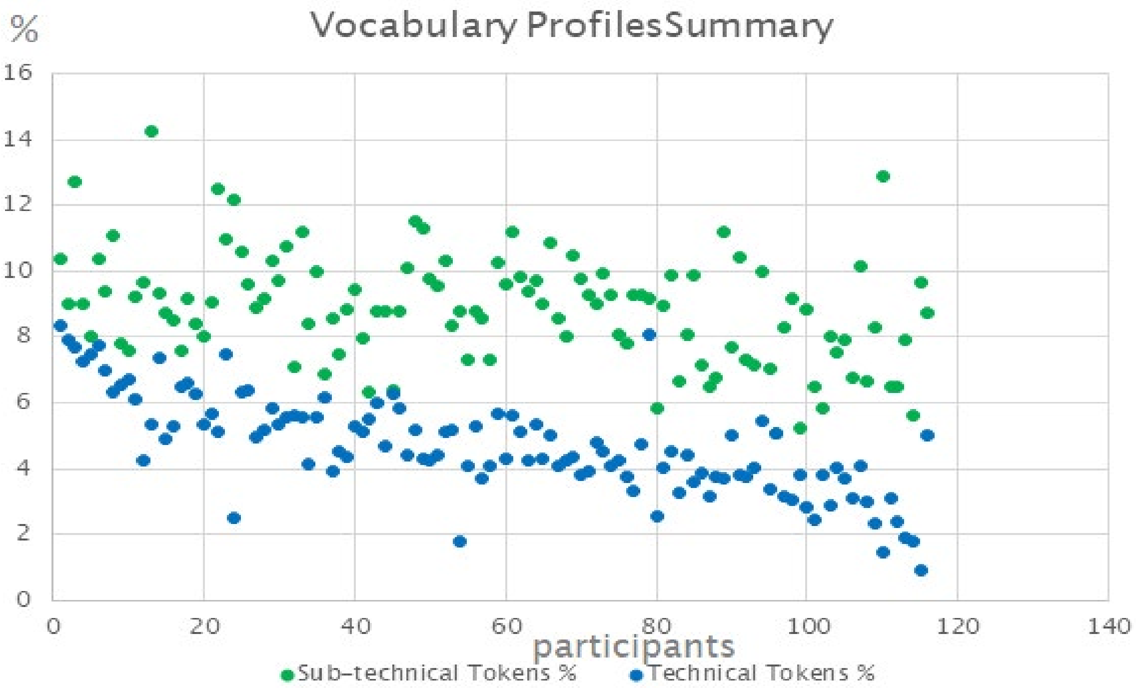


Figure 2: Visual Summary of Productive Lexical profiles from 115 participants.

As can be seen in both Table 18 and Figure 2, the use of technical vocabulary in writing was lower compared to the degree of usage of the sub-technical vocabulary. Specifically, Table 18 shows that the sum minimum, maximum and mean scores were considerably higher on sub-technical than technical vocabulary. This is evident from the lexical density mean percentage of sub-technical vocabulary usage (mean % =9.45%), which was significantly higher compared to the lexical density percentage of technical vocabulary (mean%=4.67%). In addition, the standard deviation was higher on the sub-technical vocabulary than the technical suggesting that the sub-technical vocabulary in participants' written essays was less dense and more spread than the technical. This can be visually seen in Figure 2, in which scores on productive sub-technical vocabulary appear higher than technical and it illustrates a few exceptional cases that appeared to have a much higher or lower usage of the technical and sub-technical vocabulary compared to the overall standard. It seems that the usage of technical vocabulary was lower compared to the sub-technical vocabulary.

Original Extract 1	**Profiled Extract 1**
Monoamine Hypothesis: The longest standing explanation relates to neurotransmitters in the limbic system of the brain; this controls memory and regulates mood[7]. During acute stress, serotonergic activity increases to remove the stressful stimulus, which may be internal or external, and restore homeostasis[8]. However, during chronic stress, with which the body is unable to cope, there is a reduction in this and other neurotransmitters; noradrenaline and dopamine[9]. However, it has been argued this is too simplistic as, when given antidepressants, although neurotransmitter concentration increases immediately, it is several weeks before the patient experiences an improvement in mood[10].	monoamine *hypothesis* the *longest* standing *explana tion relates* to neurotransmitters in the limbic *system* of the brain this *controls memory* and *regulates* moo d *during* acute stress serotonergic *activity* increases to remove the *stressful* *stimulus* which may be *intern al* or *external* and *restore* homeostasis however *duri ng* *chronic* stress with which the body is unable to co pe there is a *reduction* in this and other neurotransmi tters noradrenaline and *dopamine* however it has bee n argued this is too *simplistic* as when given *antidepr essants* although neurotransmitter *concentration* inc reases *immediately* it is several weeks before the pati ent *experiences* an improvement in mood
Extract1 as submitted by the participant.	*Profiled Extract1: The grey code indicates* **General**, *the green code indicates* Sub-technical *and the red code indicates* Technical *vocabulary.*

Extract 1: Monoamine Hypothesis explained in a produced essay1.

At this point, it should be mentioned here that medical students choices to use sub-technical vocabulary more frequently compared to technical vocabulary did not signify lack of subject knowledge in the area. On the contrary, most medical students' academic essays were informative and indicative of high intellectual awareness of the topic. For instance, one of the theories that could explain the onset of depression according to participants' research is the monoamine deficiency theory. This is seen on Extract 1 where the original text is placed next to the profiled text and the technical and sub-technical vocabulary were coded with red and green accordingly. It appears from Extract 1 that the participant had full awareness of the theory but the lexical choices he/she utilised resulted in a lay text ideal to address members of the public in a way that is understood. Such texts one would expect to read on social media, newspapers or leaflets. However, the example provided on Extract 2 discusses the same topic but it seems to present different degrees of usage of the disciplinary vocabulary.

Original Extract 2	**Profiled Extract 2**
Monoamine Theory The monoamine theory is a biological theory that suggests depression is caused by a decrease in monoaminergical activity. Monoamines are central nervous system neurotransmitters that are released from the presynaptic membrane into the synaptic cleft, when an action potential reaches the presynaptic terminal. The three main monoamines involved with depression are dopamine, serotonin and noradrenaline. One of the main causes of low monoaminergical activity is the metabolising action of the enzymes, monoamine oxidase A (MAO-A) and monoamine oxidase B (MAO-B)[5]. MAO-A deaminates dopamine, serotonin and noradrenaline[6] and MAO-B metabolises dopamine, thus resulting in lower levels of monoamines overall[5]. This is supported by a study[6] that have found that there is a higher density of MAO-A in depressed patients than in healthy patients. *Extract2 as submitted by the participant.*	monoamine *theory* the monoamine *theory* is biological *theory* that *suggests depression* is *caused* by ***decrease*** in monoaminergical *activity* monoamines are *central nervous system* neurotransmitters that are *released* from the presynaptic ***membrane*** into the synaptic cleft when an *action potential* reaches the presynaptic *terminal* the three main monoamines involved with the depression are ***dopamine*** serotonin and noradrenaline one of the main *causes* of low monoaminergical *activity* is the metabolising *action* of the ***enzymes*** monoamine oxidase and monoamine oxidase deaminates ***dopamine*** serotonin and noradrenaline and metabolises ***dopamine*** thus *resulting* in lower levels of monoamines overall this is *supported* by study that have found that there is higher ***density*** of in *depressed* patients than in healthy patients *Profiled Extract2: The grey code indicates **General**, the green code indicates Sub-technical and the red code indicates Technical vocabulary.*

Extract 2: Monoamine Hypothesis explained in a produced essay2.

On the other hand, Extract 2 includes a larger number of technical and sub-technical vocabulary compared to Extract 1. Such practice can make essays such as the essay on depression follow the standards of medical disciplinary writing. The lexical choices that were observed on Extract 2 seem to suggest that the text follows the standards that govern texts that are shared amongst interested experts in the field, as discussed in section 2.7.1. The use of disciplinary vocabulary (both technical and sub-technical) was higher on Extract 2 compared to Extract 1 and these lexical choices make the text relevant to medical specialists. While it is obvious that the higher technical vocabulary usage makes texts fit in with the specialised discourse of the field, the meaning and description of the Monoamine Hypothesis is informative in both samples (for an extensive analysis of the sample essays, see Appendix EE). It becomes clear from the above that lexical choices were not suggestive of poorer capacity to demonstrate subject knowledge in subjects' academic essays. The sole difference between Extract1 and Extract2 relates to the degree of use of disciplinary vocabulary which has the capacity to address lay readers (as in Extract1) or interested medical experts (Extract2).

As this essay intended to address medical experts, the faculty encouraged medical students to utilize disciplinary vocabulary in essays. However, as mentioned in this section, subjects had the tendency to produce higher rates of sub-technical vocabulary in medical essays compared to technical vocabulary. This tendency, however, did not have a significant impact on the demonstration of subject knowledge. This goes in line with findings from the RecRec, which suggest an overall tendency for higher scores on receptive sub-technical compared to technical vocabulary on the receptive recognition (RecRec) task (see sections 4.3.1 and 4.3.3). Productive vocabulary performance is discussed more extensively in relation to receptive vocabulary in the following section 4.4.2.

4.4.2 The Relationship between Receptive and Productive Vocabulary

As discussed in section 2.6.3 the relationship between receptive and productive vocabulary is a complex one and studies on the transfer from receptive to productive vocabulary provided mixed findings. In the present study, the scores on receptive recognition of technical and sub-technical vocabulary, which evidently suggested an overall development over the period of one academic semester, will be further examined in order to identify the technical and sub-technical vocabulary in terms of its association with receptive and productive vocabulary scores.

Two hypotheses regarding the relationship between receptive and productive vocabulary were generated. Specifically, lower mean scores on productive vocabulary (technical or sub-technical) could be justified on the fact that the more sophisticated receptive awareness individuals have regarding the form and meaning of a given word item, the more possibilities are available for them to produce it in context. In other words, it can be speculated that if medical students lacked awareness of word form and meaning of technical and sub-technical vocabulary, the chances of producing it in written would be considerably low. This generated two hypotheses:

- *Hypothesis 0 (null): Performance on receptive recognition is not related with productive usage of technical and sub-technical vocabulary.*
- *Hypothesis 1 (alternative): Performance on receptive recognition is related with the productive usage of technical and sub-technical vocabulary.*

The underlying rationale for H0 and H1 lies on the potential for receptive vocabulary to become productive (see section 2.7.3). Specifically, while productive vocabulary is a high maintenance skill requiring rich background knowledge in order to activate (Webb, 2009), receptive vocabulary can be activated with as little as recognition of word form (Laufer and Goldstein, 2004; Barcroft, 2002; Pellicer-Sánchez and Schmitt, 2010). In addition, the relationship between receptive and productive vocabulary is an area of division in research. Specifically, some researchers claim that a relationship between receptive vocabulary exists (e.g. Melka Taichroew, 1982; Faerch et al., 1984; Melka, 1997; Webb, 2005; Staehr, 2008; Miralpeix and Munoz, 2018), while others do not *support that this is always the case (e.g. Michel and Plumb, 2019). Considering that medical students place conscious efforts to utilize the specialised vocabulary from their resources to demonstrate subject knowledge in writing (Rogulj and Čizmić, 2018), and the field of receptive and productive vocabulary is divided, the relationship between receptive and productive vocabulary will be observed to bring further evidence on this. In the context of the present study the vocabulary that medical students were introduced to from their academic LETERs (as described in sections 3.2-3.4.5) was introduced to them for the first time during their first academic semester. It was new to many individuals and according to Melka Taichroew (1982); Faerch et al. (1984); Melka (1997); Webb, (2005); Staehr (2008); Miralpeix and Munoz (2018) it has the potential to be used productively in their academic writing. Thus, as a general standard, the degree of technical and sub-technical vocabulary received and produced will be examined in order to observe potential relationship(s) between the degree of technical and sub-technical vocabulary usage receptively and productively.*

In order to confirm the validity of the hypotheses discussed above, a bivariate correlations analysis was conducted aiming to examine the relationship between receptive and productive vocabulary for technical and sub-technical items separately and the scores are documented in Table 19. Specifically, a bivariate correlation analysis on SPSS V24 is amongst the most frequently administered statistical procedures for the data analysis of experimental studies in educational research (Hsu, 2005). Correlations usually involve a dependent and an independent variable. For the purposes of the present study, the independent variable was the receptive vocabulary scores and the dependent variable was the productive vocabulary scores.

Matched receptive and productive vocabulary data from a total of 115 participants were examined with regard to their scores on the RecRec and academic essay density scores (see sections 4.3.1; 4.3.3; 4.4.1). In the context of the present study, statistics analysis of receptive and productive scores was useful as it made it possible to observe the potential impact that the development of the receptive vocabulary had on productive vocabulary.

Table 19 illustrates the degree of correlation between the receptive and productive tasks for technical and sub-technical vocabulary. It seems that the correlation, or else, the strength of the relationship between two variables is *expressed through the correlation coefficient value (Rho-value) with Rho = .022 and Rho = -.049 for the sub-technical vocabulary and Rho = .178 and Rho = .097 for the technical vocabulary.*

Findings suggest that the overall pattern of relationships between correlations on the receptive and productive tasks indicate a slightly positive relationship between receptive and productive vocabulary. However, this relationship does not seem to be a statistically significant one. In addition to this, some correlation scores were lower or negative in the case of the association between productive vocabulary and post-task scores compared to the pre-task scores. This suggests that the observed development by the end of the first academic term on the post-task responses did not appear to have a significant impact on the productive vocabulary scores, while the pre-task was slightly more positive.

Table 19: Summary of the Bivariate Pearson's Correlation on Receptive and Productive Vocabulary.

Pearson's Bivariate Correlation Scores					
		Receptive Vocabulary Tasks			
		Sub-technical		Technical	
		pre-task	post-task	pre-task	post-task
Productive Vocabulary Task	Sub-technical	0.022	-0.049	0.131	0.007
	Sig (2-tailed)	.749	.411	.001	.919
	N	115	115	115	115
	Technical	.147	.015	.178	.097
	Sig (2-tailed)	.125	.562	.511	.346
	N	115	115	115	115

In addition to this, it should be mentioned here that all correlation scores (r) documented in Table 19 were relatively low and below the range of 0.3, which has been suggested as an indication of a relatively strong relationship in correlation analysis (Cronk, 2017). Since the correlation scores found in the present study were below 0.3, it can be concluded that the associations between receptive and productive vocabulary were low and not of a statistical significance, thus, confirming the null hypothesis. This suggests that after one academic semester's instruction and access to LETERs subjects' capacity to use the newly *learnt vocabulary in their writings would increase slightly, yet not to a statistically significant degree.*

This section aimed to present findings on medical students' productive use of technical and sub-technical vocabulary with a view to provide an answer to the third research question that this study is concentrated upon. It appeared from the findings that the density of sub-technical vocabulary was higher than the technical vocabulary in academic essays, although the relationship between the two types of vocabulary was found positive, yet weak. In addition, statistical analysis revealed that the higher scores on receptive vocabulary on the post-task did not correlate with the productive vocabulary usage of either technical or sub-technical vocabulary. This suggests that, despite the statistically significant increase of vocabulary on the receptive task, participating subjects seemed to lag behind on their productive vocabulary usage.

An additional observation can be made with regard to lexical density scores of the productive tasks in relation to the density documented on the LETERs that medical students used for their academic studies. Specifically, the MEDPRO corpus' lexical density mean percentages and the MEDREC corpus lexical density percentages suggest that the former presented significantly lower density in both technical and sub-technical vocabulary compared to the latter (see Tables 13 and 18). This finding reveals that despite the encouragement that medical students' received in order to utilize the disciplinary vocabulary in writing, their degree of usage of technical and sub-technical vocabulary was below the standard level they were introduced to from their LETERs. Findings on first year medical students' density of technical and sub-technical vocabulary in combination with the null relationship between receptive and productive vocabulary suggest that medical students' degree of usage of technical and sub-technical vocabulary in writing was below the density of the LETERs texts. It is possible that written usage of both technical and sub-technical vocabulary was at an early stage and medical students writing was not as specialised as the types of texts they encountered during their initial semester of studies. Thus, it appears that despite the obvious development of receptive vocabulary, medical students needed to enhance the usage of technical and sub-technical vocabulary to express scientific concepts. This goes in line with the writing style and expression of the genre they encountered through LETERs.

4.5 The L1 and L2 Participants' Performance on Technical and Sub-technical Vocabulary

The fourth research question is outlined in section 1.4; in order to investigate potential differences between L1 and L2 participants, the SPSS file that was generated for the purposes of the present study was split into two (93 L1 participants and 22 L2 participants). The process followed for the analysis of receptive vocabulary involved paired samples t-test analysis for the pre-task and post-task performance on the SPSS for the L1 and L2 subsets separately as described in sections 4.3.1, 4.3.2, 4.3.3 and 4.3.4. In order to investigate their receptive and productive vocabulary performance, the process of analysis of vocabulary profiles scores discussed in sections 4.4 and 4.4.1 was conducted for both L1 and L2 subsets separately and it is reported in the following sections.

4.5.1 L1 and L2 Participants' Performance on the Medical RecRec Pre-task and Post-task

The L1 and L2 subsets receptive performance on both technical and sub-technical vocabulary was examined by means of running a paired samples t-tests analysis on SPSS. As Table 20 shows, results from the RecRec examining technical and sub-technical vocabulary were statistically significant with a p-value=$p<.001$ in both L1 and L2 cohort and a marked difference was found with higher scores reported on the post-tasks compared to the pre-tasks. Specifically, L1 subjects' pre-task scores (mean= .4799 on technical and mean= .6513 on the sub-technical vocabulary) were higher than L2 subjects scores on the pre-tasks (mean= .4580 on technical and mean=.5892 on the sub-technical vocabulary). A calculation of the difference between L1 and L2 pre-task mean scores suggests that L1 participants' scores were slightly higher than L2 participants' scores for both technical and sub-technical vocabulary, as reported in Table 20. This finding reveals that L1 subjects began their medical studies with higher background awareness of technical and sub-technical vocabulary compared with their L2 counterparts.

Table 20 L1 and L2 Participants Summative Paired Samples Statistics on Technical and Sub-technical Vocabulary Performance.

Paired Samples Statistics for L1 and L2 Subjects											
		L1 Subjects					L2 Subjects				
		N	Mean	Std. Deviation	Mean Difference	Sig. (2-tailed)	N	Mean	Std. Deviation	Mean Difference	Sig. (2-tailed)
Technical Vocabulary	Pre-task	93	.4799	.14077	-.16421	.000	22	.4580	.14619	-.19818	.000
	Post-task	93	.6441	.12897			22	.6562	.08830		
Sub-technical Vocabulary	Pre-task	93	.6513	.14590	-.13233	.000	22	.5862	.15071	-.18574	.000
	Post-task	93	.7836	.16952			22	.7719	.10561		

Interestingly, on their post-task performance, the differences in scoring between L1 and L2 subjects were eliminated as both cohorts performed similarly on the post-task with minor differences. It is worth mentioning that as regards the technical vocabulary post-task, L2 participants' performance on technical vocabulary (mean=.6562) was slightly higher compared to their L1 counterparts (mean=.6441), although the difference in performance between groups was significant. This is evident from the Mean Difference scores documented in Table 20, which were higher on the L2 participants for both technical and sub-technical vocabulary. This suggests that compared to L1 participants, slightly higher language gains were achieved by L2 participants in the area of technical vocabulary.

Another statistical element that should not be ignored here relates to the scoring of the standard deviation (Std.) between the L1 and L2 subsets, which is indicative of the degree of variability in scoring. It was found that the Std on the pre-task of *technical and sub-technical vocabulary was higher for the L2 participants compared to their L1 counterparts suggesting that their answers on the RecRec were more skewed and had a higher variability at the beginning of the term compared to their L1 counterparts. However, L2 subjects', post-task performance suggests that the Std score was minimised significantly on the post-task (see Table 20) suggesting more homogenous task scores performance with more similar scores on the post-task compared to the pre-task. In sum, it is clear from the statistical analysis on both pre-task and post-task that both L1 and L2 participants improved their capacity to recognise the technical and sub-technical vocabulary receptively by the end of their first semester of studies to a similar level with minimal differences in post-task performance and a wider gap in the pre-task performance. It is evident from the data that both L1 and L2 participants ended their initial semester of medical studies with similar language gains on technical and sub-technical vocabulary.*

Findings from the paired samples T-tests go in line with a supplementary statistical analysis that was carried out on the SPSS Analysis of Variance (ANOVA). The ANOVA test examines the variability between mean scores and it compares them against the variability within each mean based on individual scores within each group. Specifically, the F-values that appear in Table 21 seem to be statistically insignificant with sig>.005. This finding goes in line with the T-test analysis reported in Table 20.

Similarly, the Test of Homogeneity of Variances on Appendix FF suggests that the homogeneity of variances between the L1 and L2 group was not statistically significant. This suggests that the comparisons between the variance means in the sample were not statistically significant. Furthermore, upon looking at the Robust Test of Equality of Means (see Appendix GG), which the SPSS offers two, namely, the Welch and the Brown-Forsythe and account for heterogeneous variances more than differences in sample size further confirm the AVOVA test findings reported above that between L1 and L2 there seems to be no statistical significance.

Table 21 ANOVA Results Table

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Medical Students Overall Response on Technical Vocabulary on the Pre-test	Between Groups	2.126	1	2.126	1.354	.247
	Within Groups	177.335	113	1.569		
	Total	179.461	114			
Medical Students Overall Response on Technical Vocabulary on the Post-test	Between Groups	.596	1	.596	.620	.433
	Within Groups	108.609	113	.961		
	Total	109.204	114			
Medical Students Overall Response on Sub-Technical Vocabulary on the Pretask	Between Groups	4.281	1	4.281	2.331	.130
	Within Groups	207.536	113	1.837		
	Total	211.817	114			
Medical Students Overall Response on Sub-Technical Vocabulary on the Post-test	Between Groups	2.808	1	2.808	3.102	.081
	Within Groups	102.286	113	.905		
	Total	105.094	114			
prodSub	Between Groups	1.087	1	1.087	.403	.527
	Within Groups	304.909	113	2.698		
	Total	305.997	114			
ProdTech	Between Groups	2.637	1	2.637	.808	.371
	Within Groups	368.920	113	3.265		
	Total	371.558	114			

4.5.2 L1 and L2 Participants' Performance on the 8 Bands of Lexical Coverage

With a view to further explain the L1 and L2 subjects' performance on the 8 bands of lexical coverage, paired samples t-test was administered for each band. This test was appropriate for the purposes of this study because it allowed the opportunity to assess L2 participants' scores on the pre-task and post-task for *each lexical band in pairs. Separate analysis was conducted for L1 and L2 participants, as illustrated in the summative Table 22.*

4.5.3 L1 and L2 Participants' Technical vocabulary Performance on the 8 Bands of Lexical Coverage

As can be seen from Table 22, L1 and L2 participants' pattern of scoring on the technical vocabulary is statistically significant on Band3-Band7 representing 70%-94% of lexical coverage for L1 and Band2-Band7 representing 65%-94% of lexical coverage for L2 participants. L2 participants achieved higher scores on Band3 than their L1 counterparts (mean=.4568 on the pre-task and mean=.6345 on the post-task with a mean difference of .24050). In addition, it was found that L1 participants had higher scores on Bands 4, 5 and 7 than their L2 counterparts on both pre-task and post-task, as illustrated in Table 22. On the other hand, Band 6 had mixed findings with L2 participants performing higher than L1 participants on the pre-task (Band6 mean=.5223) and L1 participants performing higher than their L2 counterparts on the post-task (Band6 mean=.8996). Interestingly, Band2 was observed to have a wider spectrum of statistically significant development on L2 participants with the addition of which had a -.15050 difference between the pre-task (.5495) and post-task (.6945). In addition, as can be seen from Table 22, technical vocabulary performance between L1 and L2 participants, suggests a greater variability on Std results scores on the L2 subset rather than the L1 in the majority of the cases. An emerging pattern that was observed is that L2 participants had a greater variation in scores on the pre-task, while L1 participants had a greater variation on the post-task. What this means is that L2 participants' responses had greater differences in scores at the beginning of the term and less differences by the end of it, while the opposite seems to have occurred to L1 subjects. These findings will be further discussed in section 5.7.

4.5.4 L1 and L2 Participants' Sub-technical Vocabulary Performance on the 8 Bands of Lexical Coverage

As illustrated on Table 22, a statistical significance was found on sub-technical vocabulary scores for L1 and L2 participants as discussed in the previous section 4.5.3. Thus, similarly with the technical vocabulary pre-task reported in section 4.5.3, the sub-technical vocabulary progressed in a similar way and to a similar *degree in patterns. It seems that for lexical bands: 3,4,5,7 and 8 the mean scores on the pre-task and post-task were higher for the L1 cohort compared to the L2. Furthermore, bands 1, 2 and 6 seem to have achieved higher scores on the pre-task for L1 participants and higher score on the post-task for L2 participants. Further, lexical bands 2, 3, 4 and 6 had higher mean difference on L2 participants while bands 1, 5, 7 and 8 had higher mean difference on L1 participants.*

Another finding relates to Band8 performance in which, although there was no statistical significance between pre-task and post-task performance, the scores achieved were consistent and above .50 for both technical and sub-technical vocabulary. L1 participants performed slightly higher compared to their L2 counterparts. More than half of the sub-technical vocabulary included in Band8 was effectively recognised suggesting that medical students seem to be familiar with at least half of the sub-technical vocabulary ranging between 95%-99%. While a 99% of familiarization cannot be claimed based on the scores, a 95% of recognition of sub-technical vocabulary is a safe conclusion. This suggests that both L1 and L2 participants seemed to have a basic grasp of the sub-technical vocabulary, which suggests a degree of familiarization with the sub-technical vocabulary appearing in LETERs yet not reaching full fluency (Harrington, 2018).

Furthermore, scores from the Std. on sub-technical vocabulary were examined for both L1 and L2 participants. It seemed that L1 participants had higher overall scores on Std. for bands 2, 6 and 7 on both pre-task and post-task, while on bands 1, 3, 4 and 5 their higher scores were on the post-task. As far as the L2 participants are concerned, and on bands 1, 3, 4, 5 their pre-task scores were higher than L1 participants pre-task scores. On the other hand, L2 participants presented higher scores on the post-task for Band 8. Thus far, it appears that the Std. provided an opportunity to look into variability in scoring and its' findings were mixed suggesting that on the whole L1 medical students seem to present greater variations in scores especially on their post-task while the opposite holds true for L2 participants.

Table 22 Paired Samples Statistics on Pre-task and Post-task for both Technical and Sub-technical Vocabulary Bands 1-8.

Paired Samples Statistics on Technical and Sub-technical Vocabulary Bands									
L1 Subjects		**Technical Vocabulary**				**Sub-Technical Vocabulary**			
		Mean	Std. Deviation	Mean Difference	Sig. (2-tailed)	Mean	Std. Deviation	Mean Difference	Sig. (2-tailed)
Band 1	Pre-task	.8260	.15342	-.00269	.873	.7916	.20196	.02194	.329
	Post-task	.8287	.16260			.7697	.20032		
Band 2	Pre-task	.6227	.16854	-.01172	.624	.7425	.17759	-.01667	.450
	Post-task	.6344	.22678			.7591	.17225		
Band 3	Pre-task	.4565	.18608	-.13667	.000	.4071	.18300	-.33043	.000
	Post-task	.5931	.24321			.7375	.13322		
Band 4	Pre-task	.5387	.13528	-.20978	.000	.6838	.22660	-.21925	.000
	Post-task	.7485	.12286			.9030	.35897		
Band 5	Pre-task	.5214	.24489	-.31699	.000	.6670	.20858	-.25935	.000
	Post-task	.8384	.36795			.9263	.34444		
Band 6	Pre-task	.4925	.25231	-.40710	.000	.6238	.20723	-.25591	.000
	Post-task	.8996	.36457			.8797	.19041		
Band 7	Pre-task	.3508	.20462	-.20258	.000	.4616	.24084	-.15441	.000
	Post-task	.5533	.27115			.6160	.42165		
Band 8	Pre-task	.0305	.09909	-.02613	.196	.6370	.30757	.00903	.768
	Post-task	.0567	.15579			.6280	.30739		

Paired Samples Statistics on Technical and Sub-technical Vocabulary Bands									
L2 Subjects		**Technical Vocabulary**				**Sub-Technical Vocabulary**			
		Mean	Std. Deviation	Mean Difference	Sig. (2-tailed)	Mean	Std. Deviation	Mean Difference	Sig. (2-tailed)
Band 1	Pre-task	.7605	.17067	-.12750	.007	.7123	.20853	-.11000	.034
	Post-task	.8677	.10686			.8223	.15775		
Band 2	Pre-task	.5495	.19072	-.15050	.004	.6909	.17057	-.15136	.001
	Post-task	.6945	.16809			.8423	.12728		
Band 3	Pre-task	.4568	.20027	-.24050	.000	.3459	.21487	-.38318	.000
	Post-task	.6345	.20561			.7291	.10884		
Band 4	Pre-task	.3214	.19821	-.19650	.000	.5600	.29769	-.28545	.000
	Post-task	.4586	.22014			.8455	.18482		
Band 5	Pre-task	.5055	.25747	-.39400	.000	.5905	.24801	-.27591	.000
	Post-task	.8318	.23770			.8664	.25431		
Band 6	Pre-task	.5223	.26057	-.38200	.000	.5873	.18709	-.32000	.000
	Post-task	.8936	.22144			.9073	.15776		
Band 7	Pre-task	.3050	.21997	-.23200	.002	.4432	.19286	-.16045	.011
	Post-task	.5245	.26986			.6036	.25638		
Band 8	Pre-task	.0423	.11715	-.03850	.478	.5132	.27434	-.04591	.525
	Post-task	.0709	.23158			.5591	.30958		

4.5.5 L1 and L2 Participants' Productive Vocabulary Performance

As far as productive vocabulary is concerned, L1 and L2 participating subjects' performance did not seem to be significantly different from the scores reported for the entire student sample. Specifically, as seen in Table 23, a mean score of 8.7542 and 9.5986 on the sub-technical vocabulary and a mean score of 4.7823 for the L1 technical vocabulary and 4.4936 for the L2 subjects was achieved suggests similar patterns between L1 and L2 subjects.

Table 23 Summative Table for L1 and L2 Productive Lexical Profiles Results.

Lexical Profiles Results Summary					
L1 Participants	N	Minimum	Maximum	Mean	Std. Deviation
Sub-technical %	93	5.09	14.23	8.7542	1.66984
Technical %	93	.93	8.10	4.7823	1.45292
L2 Participants					
Sub-technical %	22	7.32	12.89	9.5986	1.63964
Technical %	22	1.45	8.33	4.4936	1.85622

An interesting finding from Table 23 was the Std scores, which were higher on the L1 participants than their L2 counterparts. In addition to this, the minimum and maximum scores were quite revealing as regards to the degree of values inserted for productive vocabulary. As Table 23 shows, both L1 and L2 participants seem to have achieved different minimum and maximum scores, thus, suggesting that the vocabulary scores were unevenly distributed. It appears that since the population of L1 participants was higher compared to L2 participants, the scores on productive vocabulary were likely to be more spread. In addition, scores on Std. suggest those L2 participants' scores were more unevenly distributed compared to their L1 counterparts.

4.5.6 L1 and L2 Participants' Productive Vocabulary and its' Relationship with Receptive Vocabulary

As discussed in section 4.4.1, correlations analysis is a statistical procedure with which it can be possible to explore relationships between patterns in data. Given that both L1 and L2 participants studied medicine in their first year using the same LETERs under the same learning and teaching conditions, it was considered *appropriate to look into correlations between L1 and L2 performance on receptive and productive vocabulary scores. In order to analyse the L1 and L2 subjects' relationship between receptive and productive vocabulary for both types of lexical items examined, a correlation analysis was conducted. Pearson correlation is a statistical tool that allows comparisons between sets of data and makes it possible to observe the degree of relationship between them. A Bivariate Pearson r analysis was conducted examining the correlations between scores on the RecRec pre-task, post-task and productive vocabulary task for both technical and sub-technical vocabulary. A summary of the correlations for L1 and L2 participants is provided in Table 24.*

Table 24 Bivariate Correlation Analysis on Receptive-Productive Vocabulary for L1 and L2 Subjects.

		Summative Results Table of Bivariate Correlation Analysis							
		Receptive Vocabulary							
		L1 Participants' Scores				**L2 Participants' Scores**			
		Technical Vocabulary		Sub-technical Vocabulary		Technical Vocabulary		Sub-technical Vocabulary	
		Pre-task	Post-task	Pre-task	Post-task	Pre-task	Post-task	Pre-task	Post-task
Productive Vocabulary	Sub-technical Vocabulary ρ value	.125	.056	.071	-.033	0.112	-0.435	-.334	-.379
	Technical Vocabulary ρ value	.076	.041	.020	-.095	.190	.191	.219	.290

It appears from results on Table 24 that L1 participants' scores on correlation coefficient were stronger for technical compared to sub-technical vocabulary and a similar pattern was observed for the L2 participating subjects. In addition, it was found that L2 subjects seemed to have a stronger relationship between receptive and productive scores with regard to technical vocabulary. However, L1 subjects had a stronger relationship between receptive and productive vocabulary with regard to the sub-technical vocabulary. This is apparent from differences in standard deviations and the degrees of distribution (Mukaka, 2012), which, as reported in the previous section 4.5.5, they were uneven in both subsets.

The focus of this discussion was to contrast L1 and L2 participants' performance in terms of receptive recognition (RecRec) on the pre-task, post-task, and productive use of technical and sub-technical vocabulary as it appeared from the lexical profiles analysis scores. Findings suggest that both L1 and L2 participating subjects increased their RecRec scores on the post-task for both technical and sub-technical vocabulary with a higher improvement observed on the technical vocabulary. This finding suggests that L1 and L2 participants' capacity to recognise technical vocabulary receptively had improved significantly by the end of their first academic semester more than their capacity for sub-technical vocabulary, albeit from a lower starting level. In addition to this, out of the 8 lexical bands representing 60%-99% of lexical coverage L1 participants had statistically significant scores for Bands 3-7 representing 70%-94% of lexical coverage and for L2 subjects Bands 2-7 representing 65%-94% of lexical coverage. More advanced recognition of technical and sub-technical vocabulary was indicative of a statistically significant improvement on the post-task for both technical and sub-technical vocabulary, which further suggests room for improvement for both L1 and L2 subjects. Furthermore, the correlations analysis conducted for both receptive and productive vocabulary aiming to investigate the relationship between them suggests that the correlation between written production and receptive usage was weak and productive use of technical and sub-technical vocabulary lagged behind.

4.6 Technical and Sub-technical Vocabulary: Receptive-Productive Vocabulary and LETERs

It was shown in the previous sections 4.2.1 and 4.2.2 that in the context of the present study medical students were encountered with larger amounts of technical vocabulary in their LETERs. It remains to be seen if the pattern that was followed in LETERs was also reflected in the receptive recognition pre-task, post-task and productive task based on L1 and L2 scores. In order to complete this analysis by means of synthesizing findings from the receptive and productive vocabulary scores with the types of vocabulary stimuli received in the medical receptive vocabulary.

Table 25 and Figure 3 summarize information reported previously in this chapter (e.g. see Table 13, 15, 17, 18) and suggested that, although statistically *significant improvements have been observed in the post-task, documented in sections 4.3.1 and 4.3.3, the overall pattern of technical and sub-technical vocabulary is similar between pre-task and post-task for both L1 and L2 subjects. A similar finding to the usage of sub-technical vocabulary suggests that it seems to be the most frequently reported vocabulary in relation to technical vocabulary. In addition, it appears that productive tasks seem to follow the same pattern as the receptive recognition tasks with evidence suggesting that the sub-technical vocabulary was more likely to be recognized receptively and used productively than technical vocabulary.*

Table 25 Findings on Technical and Sub-technical vocabulary in aspects that have been studied in the present study.

Technical and Sub-technical Vocabulary		
	Technical Vocabulary	**Sub-technical Vocabulary**
Productive Use Task (Table 18)	.0467	.0945
Receptive Recognition Pre-Task (Table 15;17)	.4757	.6388
Receptive Recognition Post-Task (Table 15;17)	.6464	.7813
Learning and Teaching Resources (LETERs) (Table 13)	.374	.229

Taken together, findings from this study suggest that medical students seem to be encountered with technical vocabulary to a higher degree than sub-technical vocabulary through their LETERs. By the end of their first term of studies, their receptive capacity to recognize technical vocabulary used in LETERs seems to be progressing with time, yet it seems that this skill was not as advanced as the sub-technical vocabulary. Similarly, evidence from productive vocabulary usage suggests that the pattern of vocabulary usage for each of the two kinds of vocabulary is higher on the sub-technical rather than technical vocabulary. This finding suggests that despite the high density of technical vocabulary in medical students LETERs writings, both L1 and L2 subjects seemed hesitant to produce them in their own writings. This limited usage of technical vocabulary further suggests that medical students might have not grasped the genre and the expression of professional writing in the field at the time when the productive *task data was collected. Further discussion on this finding is provided in the following chapter.*

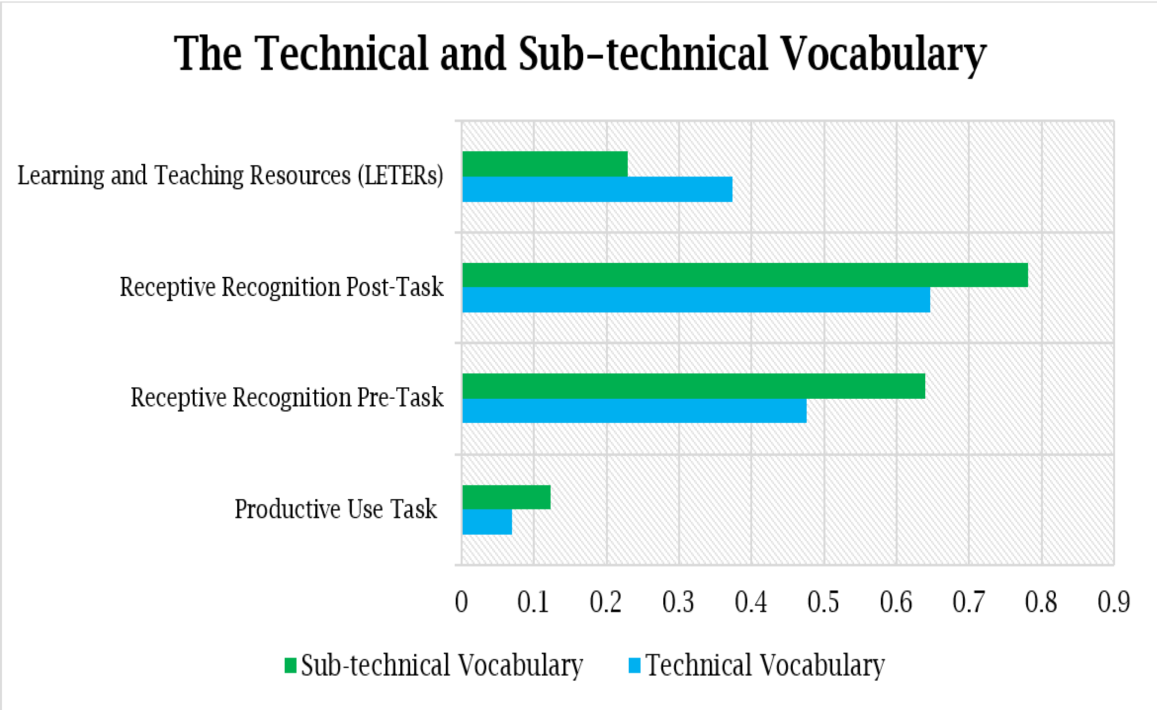


Figure 3: Summative Figure on Technical and Sub-technical Vocabulary in LETERs and Receptive and Productive Vocabulary.

4.7 Summary

This chapter discussed the findings of the present study with regard to technical and sub-technical vocabulary as it appeared from the corpora analysis conducted on the MEDREC corpus of Learning and Teaching Resources (LETERs) and the MEDPRO corpus. Specifically, the two types of vocabulary were examined on receptive level by administering the receptive recognition (RecRec) pre-task and post-task to 115 participants and on productive level by examining the lexical profiles from the productive written tasks submitted by the participants (MEDPRO). Moreover, the technical and sub-technical vocabulary was examined from the perspective of English as an L1 and L2.

Findings from the first research question suggest that lexical density percentage of Learning and Teaching Materials (LETERs) was particularly elevated on the technical vocabulary. In addition, it appeared that LETERs had differing degrees of technical vocabulary in them. Similarly, the sub-technical vocabulary was *prevalent to some of the LETERs; however, they were not represented in the majority of the corpus data collected from LETERs (MEDREC). Usage of LETERs has been confirmed and ranked by students towards the end of their academic semester and findings suggest that they utilised the majority of the resources as well as faculty designed LETERs such as lecture slides and the PiPs.*

In addition, the second research question brought forth important information regarding medical students' receptiveness of technical and sub-technical vocabulary. Despite the LETERs being heavily loaded with technical vocabulary, it was the sub-technical vocabulary that medical students seemed to be more familiar with during their initial semester of studies. On the other hand, findings from mean differences suggested that, a greater improvement was marked on technical vocabulary given that pre-task scores suggested that medical students started their semester with a lower level of technical vocabulary compared to the sub-technical vocabulary.

The third research question was answered by looking at technical and sub-technical vocabulary by means of performing a vocabulary profile (VP) analysis on participants' written essays. Findings from 115 examined essays suggested that the degree of sub-technical vocabulary utilised in them was higher than the degree of technical vocabulary. The subsequent correlations revealed that the improvement marked on receptive vocabulary did not significantly correlate with the productive vocabulary.

The fourth research question was answered by performing comparisons on receptive and productive performance on both receptive and productive tasks for L1 and L2 participating subjects. It was found that although the L1 subjects had a wider receptive capacity on the sub-technical vocabulary at the beginning of the semester, the L2 subjects caught up by the end of the term. In addition, findings on productive vocabulary suggest that the use of technical vocabulary was lower compared to the use of sub-technical vocabulary. In addition, correlations suggested that the relationship between receptive and productive vocabulary was not statistically significant. The findings discussed in this chapter will be brought together in the following chapter with a view to answer the research questions of the present study.

Chapter 5 Evaluation

5.1 Introduction

While some answers to the research questions have been provided in the previous chapter to some extent, this chapter aims to connect the dots by means of revisiting the research questions and bringing more insights gained as a result of conducting this study and concentrate on understanding and interpreting the findings in a clear and concise way. The chapter will revisit the research questions and answer them by means of critically evaluating the findings from the data in line with related literature.

5.2 Research Rationale

This study emerged from the researcher's interest in the acquisition of medical language by trainee doctors in medical schools. Medical English is a meaningful area for linguistic research since it borrows elements from a number of languages, mythical and historical themes and a number of medical words attribute their existence to them. As discussed in section 2.5, it is due to the multitude of features that characterize medical vocabulary that contribute to its' difficulty to acquire it. As a language instructor, I received multiple anecdotal reports from new L1 and L2 medical students who claimed that they were overwhelmed by the amount of challenging vocabulary they encountered during their initial semester of medical studies. This became an inspiration to conduct this research study in the belief that I can apply my linguistics background in the research of medical texts and examine key skills involved with it in order to provide a better understanding of the disciplinary vocabulary of medicine from the perspective of receptive and productive vocabulary. Early on in this project, I realized that there was no standardized test to measure medical students' receptive skills in their own disciplinary vocabulary. Therefore, in order to investigate the area, it was necessary to design and standardize a medical receptive test (RecRec) to help medical/EMP instructors and students understand the size of their medical English (technical and sub-technical vocabulary) when entering the medical school and track development during the initial months of *medical studies. Taking the above into consideration, I conducted this doctoral study focusing on vocabulary, which is typically used in the medical discipline (the technical and sub-technical vocabulary) and looked at it from the following three perspectives: reading texts, receptive vocabulary and productive vocabulary in written texts. With this in mind, I carried out the present investigation with a view to provide answers to the research questions outlined in section 1.4.*

In order to provide answers to these research questions a conceptual framework was constructed based on theories of vocabulary knowledge (receptive and productive), technical and sub-technical vocabulary and corpus analysis. Thereby, chapter 2 looked into word knowledge and issues associated with it such as incidental and intentional learning, vocabulary burden, the mental lexicon and receptive and productive vocabulary skills. In addition, it discussed the concept of technical and sub-technical vocabulary in the medical field. Furthermore, it elaborated on corpora analysis concepts such as lexical coverage and frequency along with field-specific studies.

In line with the research questions that the present study seeks to answer, a combination of corpora applications of a large volume of authentic text data, lexical profiling, vocabulary test design and implementation were employed. All texts from LETERs (section 2.3) were compiled in the MEDREC corpus of 2,097,627 running words (tokens) (section 3.4.5) the receptive recognition (RecRec task) (see section 3.6.8), an innovative tool that was designed and implemented in the context of the present study both as a pre-task and post-task to 115 medical students. In addition, vocabulary profiles on medical students' essays were generated.

The main goal of this research study was to examine newly admitted medical students' technical and sub-technical vocabulary in terms of receptive recognition and productive usage. In addition, density investigation of the LETERs and MEDPRO essays aim to examine technical and sub-technical vocabulary in LETERs texts as well as L1 and L2 students' unprompted academic essays.

5.3 Data Analysis Framework

As discussed in section 5.2, the present study combined research methodology of corpus analysis, density, vocabulary profiling and receptive vocabulary *recognition testing in order to analyse the necessary data to answer the research questions it seeks to explore. The process of corpus analysis was utilised in some parts of the study. Specifically, it was utilised during the process of MEDREC compilation and density analysis of the LETERs and MEDPRO. The purpose of conducting a vocabulary profile analysis on the MEDREC and MEDPRO was the investigation of density of technical and sub-technical vocabulary that students encounter receptively and the vocabulary they preferred to use in their productive writing. Analysis of the type of disciplinary vocabulary that medical students encounter became evident from the percentage of lexical density of technical and sub-technical vocabulary (see section 2.6) present in the medical disciplinary texts (LETERs). In the same vein, by profiling productive vocabulary it was possible to elucidate its lexical density in terms of technical and sub-technical vocabulary in writing and further explore its' relationship with receptive vocabulary.*

In addition, data from the MEDREC corpus that demonstrated the types of vocabulary appearing in LETERs were utilised in order to design an innovative receptive recognition task (the RecRec Task) suitable for beginning medical/EMP students. During the test design process, lexical coverage analysis was conducted and an equal number of word items representing 8 bands and covering 60%-99% of the LETERs texts were selected to be included in the word recognition task (see section 3.6.6). This made it possible to further explore the specific kinds of vocabulary that have been effectively recognised on the receptive level, thus, avoiding one-dimensional findings and allowing the opportunity to generate more informed conclusions as regards to subjects' receptive recognition capacity. The RecRec Task is a user-friendly Yes/No type task and it includes an equal amount of technical and sub-technical vocabulary in it representing 60%-99% of lexical coverage (see section 2.9.3) from LETERs texts. The RecRec Task was utilised in order to gain a better understanding of the amount of specialised technical and sub-technical vocabulary that medical students were familiar with, particularly with their word form. In addition, analysing the scores of vocabulary representing degrees of lexical coverage shed light on the lexical coverage that medical students were capable of reaching when reading medical texts from LETERs. The RecRec task was focused on investigating the technical and sub-technical vocabulary of medical students during their initial semester of medical/EMP studies because the LETERs it is based on reflect the type of vocabulary introduced during that period of time. It was anticipated that the research *methodology described in this thesis would provide the data necessary in order to answer the research questions and add to them by not only examining the degree of technical and sub-technical vocabulary received and produced but also by investigating correlations between different data such as the technical and sub-technical vocabulary scores on the RecRec pre-task and post-task or the L1 and L2 medical students scores on the RecRec task. Thereby, by analysing the data from the research instruments outlined in this section, findings from the present study were documented and interpreted and have provided answers to the research questions that the present study seeks to answer, and they are discussed in sections: 5.4, 5.5, 5.6 and 5.7 that follow.*

5.4 Research Question 1

The first research question is outlined in section 1.4. As discussed in sections 2.8 and 2.9 the technical vocabulary of medicine can be typical of this field, while the sub-technical vocabulary tends to be shared amongst scientific fields. Chung and Nation (2003) and Quero (2015; 2017) (see section 2.8.3) analysed the density of technical vocabulary of medical textbooks and maintained that they were heavily loaded in technical vocabulary highlighting the demands they place on medical students. In light of this, the present study looked into the density of textbooks in terms of technical and sub-technical vocabulary proportion as part of the broader variety of educational resources available for first year medical students from their medical faculty. To this end, all available resources that medical students used for their learning of scientific medical knowledge were examined in terms of written genre irrespective of their use as prompts for oral activities or delivery of sessions. Medical textbooks were also combined to gain a more informed view of the types of vocabulary introduced to medical students through their Learning and Teaching Resources (LETERs). Thus, all six LETERs included in the MEDREC corpus that reached a total of 2,097,627 running words were examined in terms of density focused in their written form. Specifically, a separate vocabulary profile analysis for each of the recommended six LETERs and a ranking task were utilised (section 4.2.3). Although each resource revealed different lexical density percentages with regard to technical and sub-technical vocabulary, a significant proportion of LETERs was found to be technical (see Table 13 and sections 4.2.1 and 4.2.2). The lexical density profiles of technical and sub-technical vocabulary appeared *in each resource. For instance, textbooks were very dense in terms of technical vocabulary. Considering the findings from the RecRec task, it is suggested that learning the subject knowledge from textbooks, lecture slides and the computer practicals (as discussed in sections 3.3; 3.4.2 and 3.4.4), might be particularly challenging for first year medical students. On the other hand, studying tutorial notes, the e-learning materials and the PiPs (as discussed in sections 3.4.3; 3.4.5 and 3.4.1), which had a lower prevalence of technical and sub-technical vocabulary, might be relatively easier to follow. While these assumptions have not been verified by medical students themselves, it can only be assumed that where the technical vocabulary appears to be dense medical students' learning of the subject knowledge might have been impeded to some degree. This is one of the implications for learning that are related to the different presence of specialised vocabulary in each of the resources.*

The present study contributes to the field by bringing more insights and building on the study of Chung and Nation (2003) which underpinned the denser nature of medical texts compared to texts from other sciences, such as linguistics. The present study was not comparative, in that it did not compare medical texts with texts from different disciplines as Chung and Nation (2003) did. Instead, it focused only on medical textbooks; thus, it can be suggested that the present thesis extends the claims made by Chung and Nation (2003) with regard to medical texts in that they have a rather dense nature in terms of specialised vocabulary included in them. In addition, this study adds more insights in Quero's (2015; 2017) studies, which focused on first year medical students textbooks. It contributes towards extending the existing knowledge in the field by looking into textbooks in combination with five additional resources that are used by first year medical students such as lecture slides, pips, tutorial notes, e-learning, computer practicals. In addition, it looked into technical vocabulary in line with Chung and Nation (2003) and Quero (2015; 2017) but also the sub-technical vocabulary, which is typical of medical texts (Hsu, 2013; 2018). The present study managed to promote understanding on the types of vocabulary encountered during the first semester of academic studies in medicine by means of profiling the LETERs.

A key conclusion drawn from the findings on the first research question is that medical students seemed to have the opportunity for incidental vocabulary encounters with a greater amount of infrequent and highly specialized lexical *items through technical vocabulary in LETERs compared to sub-technical vocabulary (see section 4.2.1). In turn, this can lead participants to develop greater awareness and expansion of vocabulary knowledge (Krashen, 1989; Ryan, 1997; Nation, 2001; Szubko-Sitarek, 2015). Thus, while medical students may initially not make full sense of a text without previous familiarization with technical and sub-technical vocabulary from their LETERs, it is suggested that it is bound to expand the more often it is met in texts (Pigada and Schmitt, 2006). In this study, the density of technical vocabulary was found to be .374 (37.4%) and the sub-technical vocabulary was found to be .229 (or 22.9%), as illustrated in Table 13. An estimation of the technical vocabulary of first year medical textbooks reached up to 23,000 new technical words (Quero, 2015; 2017) suggesting that one of the LETERs utilized in this study, such as textbooks, was found to be incredibly demanding in terms of the amount of technical vocabulary load. Given that the technical vocabulary used in medicine has been claimed to derive from Greek (58%) and Latin (21.77%) or from either of the two languages (75%) (Salager, 1985), as shown in Table 1 (section 1.3), it can be inferred that learning technical vocabulary of medicine might not be far from learning the vocabulary of classical languages. This was further supported by Coxhead's (2011) suggestion that technical vocabulary involves similar degrees of cognitive effort as a second or foreign language learning. Considering the fact that the LETERs had an increased presence of technical vocabulary, which was heavily influenced by classical languages and often adopts the idiosyncratic features governing these languages (see section 2.6), it can be suggested that it may be challenging for medical students to familiarize themselves with it at the beginning of their studies. Thus, in the context of the present study, it might be possible that the extensive usage of technical vocabulary in LETERs might have resulted in difficulties given that some medical students were introduced to it for the first time during their initial semester. At the same time, LETERs seem to teach the technical and sub-technical vocabulary of the medical discipline indirectly by means of providing sufficient authentic context and input. This suggestion was further confirmed from findings from the second research question.*

5.5 Research Question 2

The second research question that the present study seeks to answer is outlined in section 1.4. The answer to this question was not a straightforward one. This is because in studies prior to this it was difficult to examine receptive recognition of form for either technical or sub-technical vocabulary in medicine given that there was no standardised test. One of the contributions of this study is to design and administer the RecRec, which is an innovative instrument and makes it possible to examine the receptive recognition of form of the two vocabulary types, the technical and the sub-technical (see section 3.6.2). The present study designed the first corpus-based receptive recognition instrument focusing on the technical and sub-technical vocabulary that medical students encounter in their medical Learning and Teaching Resources (LETERs) during their initial months of medical studies (see section 5.4). This study is the first study to compare medical students' performance on technical and sub-technical vocabulary at the beginning and end of one academic term. One of the more significant findings to emerge from this research is that both technical and sub-technical vocabulary seem to have been significantly developed by the end of the term, as it became evident from analysis of the RecRec pre-tasks and post-tasks. The development observed on the RecRec task was focused on the recognition of form, however, findings have got wider implications since once recognition is established, new vocabulary knowledge has the propensity to lead to further development of other types of vocabulary knowledge (Stoeckel et al., 2020). In addition, this study has found that generally the sub-technical vocabulary got higher scores on the post-tasks (see section 4.3.1); however, it is not yet clear whether it is related to the challenging nature of technical vocabulary (Taylor, 2017), as discussed in section 2.5.

Nevertheless, this does not necessarily suggest that progress occurred only on sub-technical vocabulary. Specifically, this research has shown that participants developed their technical vocabulary faster during their first semester of academic studies compared to the sub-technical, as it emerged from the mean differences reported on Tables 15 and 17. This suggests that participants might have made more conscious efforts to familiarise themselves with the technical vocabulary during their initial semester. In addition, a significant lexical density percentage of technical vocabulary included in LETERs (see section 5.4) might *have contributed to this development. Thus, the findings of this study suggest that as the semester reached to an end, participating subjects seemed to have improved their technical vocabulary to a certain degree but, clearly, for the technical vocabulary of their discipline they did not achieve a similar degree of receptive awareness, as it was the case for the sub-technical. Despite the marked differences observed, post-task scores suggest that there is still a significant room for improvement for both technical and sub-technical vocabulary.*

A more in-depth analysis of the findings of the RecRec pre-task and post-task scores between 60%-99% of lexical coverage (sections 4.3.2 and 4.3.4) revealed a similar pattern in terms of statistical significance between Band1-Band8. Specifically, participants seemed to have achieved sufficient awareness of the technical and sub-technical vocabulary as it became evident that there were no significant differences marked between 60%-69% of lexical coverage. This result can be explained by the fact that when medical students study from LETERs, an approximate 69% of the texts was already familiar to them from the beginning of the term. In addition, positive statistical differences were found between 70%-94% of lexical coverage (Band3-Band7) for both technical and sub-technical vocabulary by the end of the first semester suggesting that medical students significantly improved their capacity to recognise vocabulary in their disciplinary texts over the period of one academic semester. The single most striking observation to emerge from the data analysis, as illustrated in Table 16, was Band 7, representing 90%-94% of lexical coverage, which did not fully increase on the post-task suggesting limited familiarity with vocabulary belonging to Band 7. This suggests that medical students were near the threshold for adequate receptive vocabulary (see section 2.9.3) in order to access their resources available by the end of their academic semester yet they were not ready to recognize the receptive vocabulary included in their LETERs fully in line with Prichard and Matsumoto (2011). Specifically, the 70%-94% of lexical coverage increase suggests that the students involved in the present study successfully recognized between 70%-94% of the disciplinary vocabulary of their LETERs, both technical and sub-technical, suggesting a potential improvement of their understanding (Schmitt et al., 2017). At the same time, a surprising finding is that, unlike technical vocabulary, the basic grasp of sub-technical vocabulary in medicine has been achieved given that more than half of the vocabulary representing 95%-99% of lexical coverage (Band 8) was recognized. However, it seems that despite the progress observed, there is *a significant room for improvement in both sub-technical and technical vocabulary with a view to achieve fluent and effortless reading of LETERs texts (Miralpeix and Meara, 2014; Harrington, 2018). It should be mentioned here that the RecRec task was indeed a reliable one as it is based on vocabulary from LETERs and the pre-task and post-task difference in scoring confirmed an increased awareness and development towards the end of the first term of studies (see section 4.3.3).*

5.6 Research Question 3

The third research question that the present study looked at was outlined in section 1.4. Profiling each of the 115 written academic essays, as discussed in section 3.11.6, provided a means of observation of the technical and sub-technical vocabulary pattern on receptive vocabulary and was confirmed on the productive vocabulary. As mentioned in the supplementary Appendix ii, it was expected that in order to write an essay on mental health (depression), vocabulary that is used to describe a narrow field of expertise was encouraged by the faculty but because of the popularity of the topic this was not always necessary in order to communicate scientific knowledge and expertise. Therefore, if subjects avoided the usage of highly specific vocabulary to describe abstract notions related to mental health, the essays still looked appropriate and fit the purposes of their use, which is their academic assessment from specialists in the field. In addition to this, the genre of the essay is particularly important, as it was an argumentative essay, in which the students had to generate arguments. Participating subjects supported them with updated research on the field and they were expected to describe and explain mental processes. Thus, given that the nature of the task was not narrow, it was anticipated that, while medical students had the opportunity to adopt a variety of clinical vocabulary with varied degrees of expertise in the field, a broader usage of specialised vocabulary would be acceptable in some essays. This was confirmed from findings from this study as it was found that on the submitted essay the use of disciplinary vocabulary was lower compared to the use of general vocabulary.

A key finding of the present study is that although subjects' receptive capacity for technical and sub-technical vocabulary improved, this was not clear on the productive vocabulary as it appeared on the productive tasks. A productive lag *despite the receptive vocabulary development has also been documented by Staehr (2008), Coxhead (2011), Begagić (2014), Vahabian et al. (2018), Heidari (2019), Michel and Plumb (2019), Daskalovska (2020). However, as discussed in section 4.4.1, because of the commonality of the topic of depression within scientific and lay contexts the lower use of disciplinary vocabulary did not signify less subject knowledge. It was rather making the essay appear more accessible to lay audience, yet it was not up to the standards of scientific discourse adopted by experts in the field. Nation (2001) considered avoiding the use of certain words over other words as typically occurring during the process of selecting vocabulary in order to produce discourse. In the context of the present thesis, it is clear from the RecRec Task results that subjects increased their receptive awareness of technical and sub-technical lexical items (see section 4.3.1 and 4.3.3). However, the majority of the subjects opted not to use large numbers of technical or sub-technical vocabulary productively in writing. Factors that could affect such lexical choices relate to subjects' depth of vocabulary knowledge (Nation, 2001; Coxhead, 2008), confidence and willingness to take risks with new words (Coxhead, 2008; 2021a) These factors might have had an impact on word choices in writing. In addition, the presence of prompts has been linked with lexical choices in productive writing (Laufer, 1998; Laufer and Paribakht, 1998). In the present study, participants were required to write an unprompted essay independently, structure their arguments and source information from scientific papers. Regardless of the fact that using new technical and sub-technical vocabulary was encouraged and rewarded by faculty instructors, it is likely that some individuals have not achieved it. On the other hand, they seemed to have focused on medical facts in arguments and the demonstration of knowledge and awareness of the topic as they are associated with the loss of motivation in word choices (Jones and Haywood, 2004; Coombs and Virshup, 1998; Coxhead, 2012; Booth, 2021b). Thus, it appears that the productive usage of technical and sub-technical vocabulary was often an individual choice with a variety of contributing factors towards adopting different style and expression of the discipline, as demonstrated on Extracts 1-3 (see section 4.4.1).*

In addition, the use of sub-technical vocabulary was more frequent in productive essays compared to the use of technical vocabulary. This finding goes in line with findings from the RecRec task (pre-task and post-task), as seen in section 4.4.1. Thus, it can be suggested that although medical students did possess receptive *awareness of word forms, by the time they were asked to submit their essay (end of the term), they made a substantial progress in their receptive recognition of both technical and sub-technical vocabulary and their accumulated disciplinary vocabulary was not reflected on productive vocabulary usage. Webb (2020) considers this area a very challenging one in linguistics research due to the fact that although it is possible to study the lexical items produced in writing, it remains unclear which word items participants did not choose to use productively. It is for this reason that, according to Webb (2020), research findings on productive vocabulary usage research may be considered as inconclusive. Findings from this investigation contribute to existing knowledge by providing insights with regard to the production of two types of vocabulary in writing. It appeared, thus far, that despite the extensive encounter of medical students with the technical and sub-technical vocabulary, their productive writings did not appear to reflect the vocabulary they gained from LETERs, yet they still managed to demonstrate advanced scientific knowledge. This issue will be further explored in the following section 5.6.1.*

5.6.1 The Relationship between Receptive and Productive Vocabulary

As shown in section 4.4.1 and 5.6, the relationship between receptive vocabulary development and productive vocabulary usage did not seem to be a strong one towards the end of the participating subjects' first semester. This finding goes in line with Michael and Plumb (2019) who concluded that the relationship between receptive and productive vocabulary is not a linear one. Other studies which looked into the relationship between receptive and productive vocabulary (Staehr, 2008; Coxhead, 2011; Begagić, 2014; Vahabian et al., 2018; Heidari, 2019; Daskalovska, 2020) had similar conclusions to the present work with regard to receptive and productive vocabulary highlighting a weak relationship between the two. One of the more significant findings to emerge from this study is that technical and sub-technical vocabulary on the receptive level seem to advance at a different pace unlike the productive level. Specifically, it was shown that the period of the initial academic semester might be sufficient in order to observe an increase in receptive recognition of form, however, productive usage of vocabulary might require more time and exposure to texts from LETERs. This finding has important implications for EMP/medical instructors, as it seems to *support the idea that a linguistic progress of disciplinary vocabulary (i.e. technical and sub-technical) can be possible during the initial semester, as it emerged from the present study. However, this does not signify that medical students can use their new vocabulary to communicate their ideas productively in writing. It is important to bear in mind, however, that vocabulary knowledge is a broad area; the present study focuses on vocabulary form and it does not cover all aspects such as meaning or contextual usage.*

The mismatch between receptive and productive vocabulary indicates that the two did not develop in the same way. Specifically, receptive recognition and productive usage entail different kinds of word knowledge as discussed more elaborately in sections 2.5 and 2.7. In the case of the present study, receptive recognition has been considered as a primary vocabulary skill and a less demanding type of knowledge (Nation, 2001) that participants acquire at the initial stages of their familiarization with new word items compared to productive vocabulary. In addition, Michel and Plumb (2019) reached to the conclusion that word analysis and deconstruction were associated with productive vocabulary skills. Although the RecRec pre-task and post task examined the receptive type of knowledge, it is not known how deep participants' knowledge was at the time they completed the RecRec pre-task and post-task. As far as productive vocabulary is concerned, it involves a number of advanced language skills in order to transfer from receptive to productive (see sections 2.7.2 and 2.7.3 for further elaboration). Specifically, it can be suggested that medical students may need to achieve not only familiarization with word form but also awareness of its meaning(s) and usage, which are contributing factors towards the transition from receptive to productive vocabulary (Nation, 2020). Moreover, as Laufer and Paribakht (1998) correctly point out: "both limited exposure and lack of practice hinder the successful passage of words from receptive to productive vocabulary. Receptive vocabulary may take a long time to filter into active vocabulary or may never become a part of it" (1998:397). Thus, in order to produce vocabulary one needs to gain sufficient receptive knowledge such as word form, as well as word meaning and the ability to recall the word actively in order to use it productively (Laufer and Goldstein, 2004). In addition, knowledge of the different features that constitute vocabulary may occur at different levels, which need to be completed before productive vocabulary is achieved (Melka, 1997). Moreover, the involvement of participants with productive tasks in a given language can *increase receptive vocabulary in size (Boers and Lindstromberg, 2012; Harrington, 2018 and Heidari, 2019) and possibly make the transfer between receptive to productive vocabulary smoother. As Begagić (2014) suggested "it is not surprising that participants' receptive knowledge is much better than their productive knowledge, because evidence suggests that receptive typically precedes productive knowledge" (2014:54) in line with (Miralpeix and Meara (2014). In addition, it was claimed that acquiring receptive recognition is less demanding compared to productive knowledge of a word (Nation, 2020).*

The exact circumstances under which the transfer of receptive into productive vocabulary occurred were not investigated as they go beyond the scope of the present thesis. Nevertheless, it can be safe to speculate that there is evidence to suggest that first year medical students' receptive vocabulary recognition grew significantly over the period of one academic semester; on the other hand, it seems that productive vocabulary use did not develop in a similar way. Therefore, the results of the present study suggest that medical students' productive vocabulary (both technical and sub-technical) did not seem to develop at the same time period as the receptive. This goes in line with Lee (2003), who claimed that differing degrees of productive knowledge occur at different times, as shown in Table 4. This finding could also be looked at from the perspective of the impact of LETERs on medical students' productive writing, as discussed in section 5.8. This finding has important implications for raising awareness of medical/EMP instructors who encourage medical students to utilize the new vocabulary they acquired from LETERs productively with rewards such as higher grades, as in the case of the present study, where all subjects were encouraged to use it in order to achieve higher academic marks. Considering the findings of the present study medical/EMP instructors should take into consideration that limited usage of technical or sub-technical vocabulary in writing does not necessarily imply limited receptive knowledge. By means of understanding the complicated relationship between receptive and productive knowledge as well as what it entails, it can be possible to develop awareness regarding medical students' processing of the technical and sub-technical vocabulary of their science.

5.7 Research Question 4

In order to answer the fourth research question (see section 1.4), the L1 and L2 subjects' scores were analysed separately. It should be noted that both L1 and L2 participants had the same requirements in terms of scores in key areas on their A-levels (or equivalent) and they were expected to demonstrate high levels of subject knowledge through biology A-levels (or equivalent) as well as the UCAT exam of subject knowledge, as discussed in section 3.8.1. Thus, it can be suggested that both L1 and L2 participants needed to demonstrate similar competence in terms of subject knowledge. In addition, L2 participants were expected to fulfil their requirement to demonstrate advanced knowledge in English prior to applying to the medical faculty where the present study took place. Evidence from the present study suggests that L1 participants began their initial semester with a slightly higher receptive vocabulary compared with their L2 counterparts. It is possible that L1 subjects' prior exposure to English whilst being brought up in an English-speaking environment in the UK was different compared to L2 participants familiarization with English as part of their secondary education (Coxhead and Hirsh, 2007). Despite this, one of the interesting findings of the present study suggests that by the end of the first academic semester, both L1 and L2 participants' word recognition reached to a similar level with a statistically significant difference. This finding is meaningful in that it suggests that when placed under the same learning conditions and LETERs, both L1 and L2 subjects have the potential to reach to a similar degree of receptive recognition of the technical and sub-technical vocabulary related to their subject knowledge. Thus, L1 participants' advantage of having English as an L1 would result in higher scores at the beginning of the academic semester, but towards the end of the term, the scores between L1 and L2 participants on the receptive recognition task were consistent. One factor that could explain this is the fact that L1 subjects took their A-levels exam prior to entering university in the English medium, which introduced them to concepts relevant to their initial sessions in medicine, thus, making a smooth transition into higher education. Most L1 subjects who took the A-levels exams had achieved the scores needed in courses such as biology and physics in order to enter into the Medical Faculty and, possibly, they were prepared to encounter basic concepts in medicine from the very beginning of their disciplinary studies (Coxhead and Hirsh, 2007). Based on this, it can be assumed that the participants' A-levels exams might have *contributed towards the L1 subjects' awareness of some of the vocabulary appearing in the medical discipline texts. This could explain the reason why the L1 subjects achieved higher scores on the pre-task compared to their L2 counterparts who did not take the A-levels but took an equivalent exam in another language and developed an equivalent amount of subject knowledge in a different language. It is possible that L2 participants were aware of equivalent terms of the subject knowledge in their own languages and not in English. It appears that one of the reasons that can justify L2 participants' lower scores performance on the pre-task for both technical and sub-technical vocabulary lies on the fact that at the beginning of the course when the pre-task was administered L2 participants had already received their subject knowledge exams in languages other than English. Therefore, it was a matter of time, for L2 participants to develop their already existing medical subject knowledge in English.*

In line with the above, the differences in performance in each of the eight bands of lexical coverage between L1 and L2 subjects were alleviated upon one semesters' exposure to the technical and sub-technical vocabulary of the discipline. Contributing factors for L2 participants' performance development on the post-task might be stay in the UK and, potentially, their awareness of additional languages as part of their secondary education (see section 3.8.2). The advantages of awareness of other linguistic systems or classical languages, such as Latin and Greek, lie on the fact that students might be better able to take on a more analytical approach to technical and sub-technical vocabulary by decomposing word parts (as discussed in section 2.5.2). Thus, learners could process word parts more effectively, rather than take the less economical approach of having to learn the meaning of each technical or sub-technical word item independently.

Interestingly, a pattern that emerged from both the L1 and L2 participants' productive tasks was that they had the tendency to produce more sub-technical than technical vocabulary. This finding suggests that in order for L1 and L2 subjects to express themselves in written English of similar standards to their LETERs, they preferred to use more sub-technical than technical vocabulary, which is the opposite pattern to the LETERs texts (see section 5.4). This suggests an overall productive fluency was geared more towards sub-technical vocabulary *and less towards technical vocabulary for both L1 and L2 subjects. This is obvious from Tables 13 and 18, which illustrate the density of the MEDREC and MEDPRO corpus, where the percentage of usage of technical and sub-technical vocabulary in the MEDPRO was significantly lower compared to the MEDREC. When the relationship between the two types of vocabulary was examined in terms of receptive and productive level, a negative relationship was found on the sub-technical vocabulary for both L1 and L2 cohorts and a weak positive was found on technical vocabulary only for L2 subjects. This was a surprising finding given that the L2 subjects achieved higher scores in technical vocabulary post-task than their L1 counterparts. This finding could be justified on the basis that L2 participants might have been more effective in tackling technical vocabulary compared to sub-technical vocabulary at the beginning of the term and over the course of one semester, they appeared to have improved both types of vocabulary marking a relatively close mean difference. Overall, the observed differences between L1 and L2 participants' productive usage of technical and sub-technical vocabulary were minimal. This finding is contrary to Gablasova (2014a), who found that there seem to be significant differences in lexical choice of disciplinary vocabulary in English between L1 and L2 learners with L2 learners lagging behind L1 learners in terms of disciplinary vocabulary usage. One possible explanation for this is that while the present study, as well as Gablasova's (2014a) study, looked into productive disciplinary vocabulary, Gablasova (2014a) focused on oral production while this study concentrated on written production. Specifically, writing texts in a discipline is a process that takes longer, it undergoes editing, drafting and redrafting, while oral presentation skills is a more spontaneous process and, as Gablasova (2014a) correctly observed, it involves skills such as automatic retrieval and instant lexical choice. Therefore, findings of L1 and L2 medical students' productive vocabulary are applicable specifically in writing skills and cannot be generalised in oral productive usage of technical and sub-technical vocabulary in English by L2 participants.*

Based on the findings of the present study, which investigated both receptive and productive vocabulary in written form and not on spontaneous recognition or production, it is not possible to guess how quickly or effectively the two groups of participants would have processed the same information as this goes beyond the limits of the present study. However, what we do know is that, contrary to the belief that L2 learners might be at a disadvantage for familiarizing themselves *with the vocabulary of the discipline during their initial semester of medical studies, they developed their receptive and productive vocabulary equally well and, on average, they performed similarly to their L1 counterparts by the end of the term. This goes in line with Coxhead (2011) who claimed that learning disciplinary vocabulary requires the same cognitive effort as learning a foreign language. Based on this, it is safe to suggest that, in the context of the present study, both L1 and L2 subjects encountered similar challenges in their learning process of the technical and sub-technical vocabulary related to their subject knowledge. Moreover, it was shown that English as an L1 without awareness of other linguistic systems is not necessarily an advantage when it comes to disciplinary vocabulary development of receptive recognition and written use.*

5.8 The Role of Incidental and Intentional Vocabulary

Findings suggest that the vocabulary introduced in LETERs was not reflected similarly in neither receptive nor productive vocabulary in terms of the lexical density percentage of technical and sub-technical vocabulary found in LETERs suggesting weak incidental vocabulary learning. Specifically, LETERs offered the opportunity to medical students to read disciplinary texts that were dense in terms of technical and sub-technical vocabulary and the act of reading is considered as one of the most effective ways to introduce learners to incidental vocabulary (Krashen, 1989). As discussed in section 2.3, out of the three factors outlined with learning incidentally such as providing students with texts that interest them, offering authentic texts and selecting texts based on learners current vocabulary competence (Nagy et al., 1985; Cho and Krashen, 1994), the first two out of the three factors were confirmed in the present thesis. Specifically, medical students subject that interests them and authentic learning and teaching materials (LETERs) were available to participants. However, the third factor, which relates to selecting texts by considering learners' current level of competence, seems to be inconclusive given that medical instructors may have a legitimate reason to recommend or design LETERs based on the curriculum learning goals overlooking the complexity of texts in terms of vocabulary usage. In this study, incidental vocabulary seemed to take effect on receptive vocabulary, however, the heavy load of technical vocabulary in LETERs was not reflected neither on students' receptive nor on productive tasks (see sections 4.2, 4.3 and 4.4). This finding is meaningful in that it suggests that reading materials can *positively increase incidental vocabulary of word form in line with Cho and Krashen (1994) and Pigada and Schmitt (2006). However, this increase does not mirror LETERs proportion of coverage, as shown from statistical differences reported in Figure3.*

While incidental learning can be an important reason to select or write texts with significant complexity in LETERs, it is recommended that increasing medical students' opportunities of encountering demanding terms can lead to effective mastery of vocabulary and expression (Pigada and Schmitt, 2006; Vahabian et al. 2018). Although adding more reading to an already full schedule may be an appealing solution, it is important to consider the cost that comes with it such as the use of additional time (Pellicer-Sánchez and Schmitt, 2010). On the other hand, recall mastery can be achieved simply from reading LETERs with enough planned repetitions in context, (Schmitt et al., 2001; Staehr, 2008; Miralpeix and Munoz, 2018). It seems, therefore, advisable to add explicit recall tasks to achieve recall mastery, rather than wait for large number of exposures to be achieved from reading alone.

It can be suggested that medical students would have possibly involved both incidental and intentional learning of the target vocabulary through attending sessions and accessing LETERs, thus, becoming acquainted with it. Specifically, it is possible that medical students effectively acquired new words incidentally from the target disciplinary vocabulary included in their LETERs and during lectures and practicals. At the same time, they might have been intentionally learning vocabulary from their resources in order to be better able to respond to their academic demands. It was claimed by Sinclair 1997, for instance, that medical students place a significant importance in learning the vocabulary of their subject knowledge. As such, it would not be surprising that medical students were intentionally learning the vocabulary of their discipline in order to cope with their study demands. Due to the limits of the present study this assumption is difficult to confirm from medical subjects, however, it remains to be seen with future research if medical students utilize one way of adding the disciplinary vocabulary in their mental lexicon or the other or a combination of both.

5.9 Summary and Conclusion

This chapter aimed to provide a discussion of the answers to the research questions narrated in section 5.2. The key finding of the present study is that there is a mismatch between the technical and sub-technical vocabulary present in LETERs in relation to receptive and productive vocabulary. In addition, participants confirmed and ranked their usage of LETERs (see section 4.2.3). Findings from the lexical profiling of LETERs suggest that participants were exposed to a higher degree (37.4%) of technical than sub-technical vocabulary (22.9%) (see sections 4.2.1 and 4.2.2) from their LETERs, as shown in section 4.2. Thereby, when studying to consolidate scientific facts or prepare for their exams or academic essays, medical students were encountering a significant number of technical vocabulary rather than sub-technical.

Despite the apparent load of technical vocabulary in texts from LETERs that was introduced to participants, it were not clearly reflected neither on receptive nor productive task. What this means in simple terms is that while medical students were exposed to higher numbers of technical than sub-technical vocabulary when reading from their LETERs, the reverse occurred in both their receptive recognition and productive usage. As discussed in section 5.5, the mismatch between technical and sub-technical vocabulary suggests that medical students were exposed to its' form and a variety of meanings from LETERs, however, not all of it was retained effectively at the end of the term when they completed the post-task. In addition, although medical students had received a number of examples of technical vocabulary used in medical discourse from their LETERs, they did not effectively produce it in their own medical discourse (for further discussion, see section 5.6). Despite this, there is evidence to suggest that students' receptive recognition skills of technical and sub-technical vocabulary expanded during the first academic semester of studies (see sections 4.3 and 4.4). Further analysis on lexical bands suggests that medical students' receptive capacity reached up to 94% of lexical coverage for the technical and above 95% for the sub-technical vocabulary in learning and teaching materials available to participants at the time of the present research study. In addition, it found that L1 and L2 participants marked a similar threshold by the end of the semester on both receptive and productive tasks.

Chapter 6 Conclusion

6.1 Introduction

This chapter aims to present a summative picture of the thesis by means of providing an overview and the limitations that might have affected the findings. In addition, the implications and originality of the present research study in the area of vocabulary research in English for Medical Purposes (EMP) is discussed. Finally, it utilises the findings of the present research for practical considerations to the medical faculty that the present study took place in order to maximize medical students' potential for gaining more technical and sub-technical vocabulary more effectively and provides suggestions for further research in the field.

6.2 Overview of the Present Research Study

The present study responds to a gap in the literature of vocabulary studies in English for Medical Purposes (EMP). Specifically, Chapter 1 and, more thoroughly, Chapter 2, indicated that so far vocabulary studies in EMP focused in the area of text analysis and concluded by suggesting technical or sub-technical vocabulary wordlists for EMP/medical instructors to use. Although they helped provide a better understanding of the vocabulary present in the specialized genre of medicine, they did not base their studies on a variety of authentic samples from Learning and Teaching Resources (LETERs) that medical students encounter during the initial semester(s) of their academic studies in medicine. In addition, no study so far has examined medical students' receptive or productive vocabulary of the discipline; one reason for the former might be that there was no standardized tool to facilitate testing of the technical and sub-technical vocabulary of the discipline (see sections 2.8.3, 2.9 and 2.11). In addition, the reason(s) why medical students' productive vocabulary had not been investigated before the conduct of the present study remain unknown. Furthermore, at the time of the present study, most EMP vocabulary research focused on the needs of L2 medical students and no research study involved L1 medical students in their research sample. In order to cover this gap in the *existing literature, the present study concentrated on four research questions outlined in section 1.4.*

In order to answer these questions, a research methodology was implemented, as described in Chapter 3. Specifically, the Learning and Teaching Materials (LETERs) were compiled in the MEDREC corpus, which was of a considerable length of 2,097,627 running words, and an examination in terms of its technical and sub-technical vocabulary composition was carried out. In order to answer the second research question, the MEDREC was deployed according to technical and sub-technical vocabulary and vocabulary covering various degrees of lexical frequency was classified and analyzed in terms of its' frequency and range of appearance in LETERs. Technical and sub-technical vocabulary that was balanced and representative of different degrees of lexical coverage was utilized in the generation process of the Receptive Recognition (RecRec) Task. In addition, in order to answer the third research question, medical students' essays were compiled in the MEDPRO, which consisted of 209,160 running words and it was profiled with regard to the amount of technical and sub-technical vocabulary included in them. Furthermore, individual differences in scores between a total of 115 L1 and L2 participants who took both the receptive and productive task were statistically analyzed to answer the last research question.

From the results that the present study draws on Chapter 4, it appeared that the LETERs included more technical than sub-technical vocabulary and medical students' receptive vocabulary as documented on the RecRec grew significantly by the end of the initial semester of studies (both technical and sub-technical). On the other hand, the productive vocabulary did not follow the same fashion as the receptive vocabulary with medical students lagging behind in their productive usage of both types of vocabulary. In addition, performance between L1 and L2 medical students on both receptive and productive vocabulary followed a similar pattern to the overall findings of the present study. The findings were discussed in Chapter 5, which revisited and discussed them in line with related research. This chapter aims to bring forth key aspects related to this study and conclude the present thesis.

6.3 Limitations

Limitations are usually present in academic research studies and it is important to acknowledge and identify them. One of the limitations of the present study relates to the lack of control over participants' personal involvement with the LETERs, which became the main source of vocabulary data for the design of the receptive (RecRec Task). Vocabulary input was examined and medical students confirmed that they did utilise LETERs provided from the medical faculty. In addition, the degree of medical students' actual use of and involvement with the LETERs for the purposes of their own personal learning remains unknown. As MEDREC data was streamlined based only on the medical faculty's recommendations for LETERs, it did not include other sources such as websites or textbooks not included in the recommended bibliography list.

In addition, the receptive recognition (RecRec) Task is limited in terms of its' testing capacity as it focuses on the word form/spelling. Specifically, it is geared towards the assessment of students' recognition of word form as it has been claimed to be a basic word skill and it is one of the first skills to develop when learning a new word item before building on more skills (Nation, 2010). By focusing on the word form of the RecRec task, other aspects of word knowledge such as understanding of meaning(s) were not studied in the present research, thus, there is a lack of generalizability of the findings on other receptive skills (Salager, 1983). At the same time, as Pignot-Shahov (2014) correctly observed, "it is impossible to test all the different knowledge facets of a word at the same time" (2014:37). Considering the complexities that word knowledge entails, it can be particularly challenging to innovate measuring tools that bring answers to one aspect of word knowledge without affecting other types of it (Schmitt, 2010). Considering the above, the present study focused on examining one aspect of single-word-item knowledge (word form) and made the findings of this study specific to that particular aspect. One of the limitations of the present study relates to the lack of involvement of multi-word units, which tend to be very popular in the medical genre. The technological and time restraints of the present study did not facilitate this process and research in this field is still inconclusive. Due to this, future studies are encouraged in this area of research.

In addition, the Yes/No type of testing may lead towards an overestimation of knowledge (Mochida and Harrington, 2006) by random choices that were not picked up by the imaginary words and may lead to untruthful scores on the receptive task. This weakness was known; however, as mentioned to sections 3.6, 3.6.1 and 3.6.2, the RecRec task type and word knowledge it tested was influenced by the context where the present study took place given that medical students had an overloaded schedule at the time of data collection. Therefore, a user-friendly task was deemed as more appropriate than a lengthier or more complicated one. In addition, the instruction word included on the RecRec task, which is the generic word "know" (see section 3.6.8) might have led some subjects to misunderstand it especially if they did not pay attention to the oral instructions provided by the researcher at the time of pre-task and post-task administration. Therefore, there is a possibility for misinterpretation of the written instruction on behalf of the students when requiring them to tick only on words that they knew in terms of one or more meanings. Thus, the findings from the RecRec task are limited to medical students' word recognition of form for the specific context and cannot be generalised to other aspects of knowledge of medical vocabulary.

In addition, such kind of study could produce findings that would be more useful had it been a longitudinal one. Since this was not possible due to time, practical and financial constraints, collecting data over the period of one academic semester was deemed as sufficient for the completion of the present thesis. However, this is rather limiting the generalisability of the findings due to the possibility that a different degree of linguistic development might have occurred to subjects by the end of their first, second or final year of their undergraduate academic studies. Therefore, the findings of the present study are limited to the context of medical students' first semester of academic studies, which in the present study it aimed towards orienting them with medical science.

In addition, operationalising a corpus analysis with a view to identify and review some parts of the process, comes with limitations such as the absence of medical expert evaluator(s) who would decide on the technicality of a disciplinary vocabulary item or classify it in bands. Due to this limitation, corpora analysis software was used instead with a view to identify the technical and sub-technical vocabulary in LETERs and classify it in bands. The fact that this study is corpus-based in this part has been linked with advanced objectivity in findings (Chung *and Nation, 2003). However, it can be argued that it cannot replace human interpretation and expertise. In addition, different word frequency bands were used as a means to determine the middle area between General English and technical vocabulary, which was termed as sub-technical vocabulary. The BNC wordlists were used as a guide to help researchers and teachers focus on the most needed vocabulary included in reading sources of medicine such as textbooks and/or journals (Wang et al. 2008; Hsu, 2013). It should be mentioned here that the BNC wordlists, which were available to the researcher at the time of the present study, contain information that may be considered as outdated compared to the current communication needs of the students in terms of their vocabulary awareness. Therefore, the findings of the present study on the types of words that constitute sub-technical vocabulary in medicine should be treated as the sub-technical vocabulary applicable at the time when the BNC wordlists were extracted, which is the 1990's. Findings on sub-technical vocabulary identified in the present study is limited to the period of data collection as it is expected that the disciplinary language might have evolved and undergone some changes.*

Another limitation that the present study relates to the longer-term validity of the RecRec task based on the MEDREC corpus. The corpus relied on resources that were up-to-date at the time of data collection for the conduct of the present study. Medicine progresses, advances and new concepts are described using new or already existing words. At the same time, frequency wordlists (e.g. the BNC) may change over time as new words can be used more frequently while old frequent ones may no longer be used as often. Thus, the frequency-based approach as a method for used for identifying specialised vocabulary can be limited as to what it can offer. Therefore, while the target population that the RecRec Task addresses is beginning EMP/medical students, who are usually receiving basic medical knowledge such as the anatomy of the human body or basic bodily functions, it may be possible that terminology and language might change. As medicine, is a scientific field that advances rapidly, it is possible that the RecRec task may become outdated with the passage of time. This limitation needs to be considered if the suggestive RecRec Task is utilised by fellow researchers in the future.

As far as the productive vocabulary that was examined in the present study, there are limitations, which relate to the essay topic that need to be considered.

Specifically, the way the essay question was designed might have affected the vocabulary medical students produced as Booth (2021b) points out "it is still unclear the extent to which the differences in question topics might have influenced the frequency profiles" (2021:198). In addition, the topic of the productive task related to depression and students were encouraged to examine it based on a case study example. Although depression can be approached from a clinical perspective, it has been investigated extensively within a variety of perspectives across disciplines, such as psychology, anthropology and sociology. Thus, it might be possible that students' lack of experience with conducting academic research might have focused on clinical medicine resulted in essays lacking clinical depth and this might have been reflected on their vocabulary choice, which was not assessed for its accuracy of usage as this goes beyond the scope of the present study. In addition to this, it is important to consider that the productive task scores may not reveal the participants' degree of avoidance, which relates to students' preference to avoid using certain word items consciously when using language productively, for example, when writing. Therefore, avoidance of usage of word items bears its own limitation that needs to be considered when interpreting the findings of productive vocabulary use.

In addition, the number of recruited L1 and L2 subjects was not equal due to the fact that the admission policy on the medical faculty where the study was conducted involved limited spaces for non-UK students. This resulted in limited L2 participation and an unequal L2 sample compared to the L1 sample. Although the statistics package utilised was able to generate reliable statistical findings for the purposes of the present study regardless of sample representation, this limitation still needs to be considered. In addition to this, the variety of first languages that L2 participants identified themselves with made it impossible to classify L2 subjects with a specific first language group. Therefore, the analysis based on L2 students' receptive and productive performance is suggestive and not conclusive.

Another limitation is related to quantitative approaches to language analysis, as discussed in section 2.4; measuring language has been associated with the disadvantages associated with quantitative-related studies. For instance, according to Baker and Lebov (2015), corpus-based researchers may rely on statistical data and often lack insights or critical appraisal of the data and focus *on atypical language and expression. This goes in line with McEnery and Gabrielatos (2006), who suggested that the automated and impersonal nature of corpora might lack critical evaluation. While the semantic rating scale might have contributed towards alleviating the weaknesses of corpus analysis, as discussed in section 2.9, due to the size of the corpus, it is rather challenging to be implemented as it can be a strenuous and time-consuming process, as reported in previous studies (e.g. Quero, 2015; 2017). As findings for the present study based upon computed output and lack the insight from subject specialists' opinion, results should be treated with caution. In addition, more corpus-based studies with wider focus on aspects of vocabulary analysis other than word tokens (i.e. polysemy, multi-word units and collocations), are encouraged to move beyond the limits of the present study are required and further the findings of the present study.*

Overall, this study looked into vocabulary size and produced findings that are extrapolative and inferential and cannot be taken as precise and conclusive, which is a common limitation with vocabulary size studies. Specifically, the types of words documented in the receptive and productive tasks are balanced and representative of technical and sub-technical vocabulary of different levels and do not assess how well participants know words receptively or how accurate their productive usage can be. Thus, findings should be interpreted with caution and they are specific to first year/semester medical students. It can be suggested that future research may move forward by means of combining vocabulary size and depth to produce findings that offer more insights.

6.4 Original Contribution and Significance

This study contributes to the advancement of knowledge in the growing field of vocabulary studies in EMP (Ferguson, 2013) (see section 2.11 and Table 7) by designing piloting, administering and making the RecRec Task available to the research community (Appendix Z-DD). The RecRec Task is a lexical recognition task that was designed by combining the principles of corpora compilation and analysis and text coverage of technical and sub-technical vocabulary representing a range of 60%-99% coverage (see section 3.6.3). It is based on LETERs, specifically designed for first year medical students and was utilised in the present study in order to generate some of its' findings. Findings from the RecRec *aim to enhance Medical/EMP instructors' awareness of the technical and sub-technical vocabulary level that medical students have during their initial semester of medical studies. Furthermore, an outcome from the implementation of RecRec is to raise awareness and make more informed choices on the type of LETERs used during the semester based on learners' current level of technical and sub-technical vocabulary size. This goes in line with Krashen and Terrell (1983), who suggested that attuning texts to learners' level of language competence can lead to effective incidental learning (see section 2.2.1). Thus, this study adds more to the field by following the principles of lexical coverage analysis in order to explore vocabulary size in experimental research. Thereby, it shifted from using lexical coverage in order to be able to judge texts' suitability for learners of a specific level of English (Harrington, 2018) to actually utilising it to design the RecRec vocabulary test. It is suitable for use by both L1 and L2 learners who are beginning medicine/EMP to document or track the development of their vocabulary size over time.*

In addition, the present study adds more breadth in the area of EMP by investigating and documenting the degree of technical and sub-technical vocabulary that not only L2 but also L1 medical students encounter while reading their suggested study materials. This is because it was reported in Sinclair (1997) that L1 medical students on their initial semesters of study encounter difficulties with learning the vocabulary of the medical discipline. In addition, so far no study has utilized the wordlists that emerge from the lexical coverage output with an aim to test learners' knowledge of different degrees of lexical coverage to measure vocabulary size (van Zeeland and Schmitt, 2012). The present study has filled this niche by utilizing the lexical coverage output from specialized medical language data towards the development of an assessment tool measuring receptive recognition (RecRec). The RecRec is a receptive recognition task, which aims to assess primary receptive knowledge and familiarity with the written form of technical and sub-technical vocabulary. The implementation of the Yes/No test did essentially manage to examine vocabulary size, which was deemed as impossible by Castellano-Risco (2018). In addition, it examines the degree of usage of technical and sub-technical vocabulary in unprompted productive writing during the initial year of medical studies when vocabulary and expression typically utilised in their secondary education writing is adapted to the vocabulary and expression that is typically used between members of the medical *discipline community. By profiling the degree of usage of technical and sub-technical vocabulary in writing, it can be possible to enhance awareness of the amount of technical and sub-technical vocabulary typically encountered and used by medical students during their initial year of studies. This awareness can enable EMP and medical instructors who practice medicine for a long time to adjust their expectations as regards to the extent that medical students gain a basic knowledge of a word and use it in writing, thus, generating more informed decisions. In addition, such awareness may help medical instructors design or administer activities that are suitable for learners' current level of expertise, thus, enhancing effectiveness and making the learning and teaching process student-led. Finally, the wide participation from the medical student population who embraced this project makes this study one of the first experimental vocabulary studies in the field.*

6.5 Implications

This section aims to discuss the implications of the present study in the context where it was conducted. Given that a large component of the present study was corpus-driven, it may have an impact by means of providing further suggestions for developing excellence in areas such as the quality of learning resources, examination standards and program specifications (Mitchell, 2021) in the UK faculty where the present study took place. Although the learning and teaching implemented so far in the faculty does make great doctors as a result, there is still some room for improvement based on the findings from this study. In this section, the implications from the present study with regard to disciplinary vocabulary (i.e. technical and sub-technical vocabulary) will be provided along with practical recommendations for medical/EMP instructors with a view to enable medical students make the most of their learning of the disciplinary vocabulary during lectures or tutorials.

The first implication of this study is that it provides the opportunity to shed light on the learning burden of medical students' Learning and Teaching Resources (LETERs) during their initial semester of medical studies, gain a better understanding of it, and inform the current theory of learning from evidence-based data from corpora applications. It became evident that medical students encounter a significant number of foreign originated words that carry technical *meaning in medicine, thus, adding to their learning burden (see sections 2.4 and 2.6; 4.2.1, 4.2.2 and 5.4). Equipping medical students with the necessary word deconstruction skills and learning strategies can offer them the tools they need in order to decompose medical vocabulary into its components and use contextual cues to infer the meaning of the unknown vocabulary from word roots/stems more methodically (Rogulj and Čizmić, 2018). In addition, the hypothesis that disciplinary vocabulary recycles itself in students' Learning and Teaching Resources (LETERs) can be evidenced by means using corpora analysis tools.*

A second implication of the present study derives from the discussion in sections 5.6.1.and 2.7.3 on the complexity that the relationship between receptive and productive vocabulary entails and what contributes to this is that usually receptive vocabulary tends to expand first and, upon sufficient expansion, it becomes productive. Thus, generalisations on productive vocabulary knowledge based on receptive vocabulary should be avoided because while receptive capacity seems to improve during the semester, it does not always suggest an equivalent productive use in unprompted academic essay writing (Michel and Plumb, 2019). Specifically, as the program stands, Medical/EMP instructors, faculties and individual medical instructors should consider adjusting the marking criteria specifically for first semester undergraduate students as one of them aimed towards the written use of disciplinary vocabulary as a means to gain additional marks in essay assessments (see Appendix A). This is because findings from the present study revealed that medical students' recognition of receptive vocabulary was more advanced than productive vocabulary usage. This means that students who might perhaps use a lower number of disciplinary vocabulary might possibly have a broader awareness of it receptively.

One practical implication that can be drawn from the above relates to developing and improving current learning and teaching practice by increasing the amount of learners' time and opportunities for exposure to the same word item(s) in order to strengthen receptive knowledge and build productive awareness of word usage. This has been claimed to lead towards developing fluency both receptive and productive (Schmitt, 2000; Beck et al., 2013) given that multiple encounters of the same lexical item(s) increases the chances of retention (Nagy, 1997). Thus, vocabulary activities such as short pre-lecture and in-lecture tasks focusing on form and meaning can maximise recycling and rapid vocabulary intake of new *disciplinary vocabulary items (Aviad-Levitzky et al., 2019) if they are complemented with further elaborations and explanations during sessions. In addition, short group tutorials encouraging students to find out the history/myth surrounding the etymology of key terms can offer peripheral knowledge, stimulate imagination, increase cognitive involvement, engagement and ownership. This can lead to larger and longer vocabulary gains.Thus, by increasing intentional opportunities for incidental learning (see section 2.2.1), it can be possible to maximize disciplinary vocabulary acquisition and lead to productive vocabulary development (Corson, 1997; Rogulj and Cizmic, 2018) and a student-centered mode of learning and teaching. The need to devise vocabulary task activities is real and necessary with a view to focus more on key vocabulary. For instance, complementing LETERs with vocabulary recall exercises can maximize incidental vocabulary learning in a fast and efficient way in line with Pellicer-Sánchez and Schmitt (2010). It can be argued that there is a plethora of vocabulary activities online and/or on textbooks. Findings from the ranking task of the present study suggest that so far first year medical students tend to place more trust on the materials designed by their own lecturers and faculty (e.g. the lecture presentation slides and PiPs) than external resources (see section 2.3). This has also come to my attention when talking and studying side to side with medical students in the library. Tasks or activities designed by the faculty were considered as priority texts compared to tasks widely available online or on textbooks. To this end, developing collaboration between EMP/medical instructors and corpus linguists with a view to identify key vocabulary that appears in LETERs and devise short vocabulary tasks may help reduce medical students' learning burden (see section 2.4). By engaging in activities specifically designed to familiarize and recycle key vocabulary that appears in LETERs, it can be possible to maximize gains during lectures without making a difference on the medical curriculum but making a difference on medical students' vocabulary intake per session. Thus, it can be possible for first year medical/EMP students to leave the lecture/tutorial room with more vocabulary gains and a lighter vocabulary load for their personal study (see section 2.4) allowing them to focus on medical facts rather than unknown key vocabulary.*

A final implication of the present study relates to the development of a methodological instrument for the investigation of the technical and sub-technical vocabulary in the medical discipline, the Receptive Recognition Task (RecRec

Task). The RecRec task is original and aims to fill a gap in the research methodology of EMP vocabulary as to this day no standardized research instrument is utilized in order to test the disciplinary vocabulary in EMP. The RecRec Task examines two types of vocabulary in one test. Specifically, both technical and sub-technical vocabulary of the discipline were represented in the task equally. In addition, lexical items cover 60%-99% of text and are included in the RecRec task in random order. It is based on a 2,097,627 running words medical corpus (MEDREC) that represent vocabulary from 6 types of LETERs that medical students were introduced to during their initial semester (see sections 3.2-3.4.5). Furthermore, the RecRec task is simple and reliable as a number of imaginary words have been included in it to adjust the scores (see section 3.7 and Appendix T). Moreover, it is user-friendly, quick and easy to administer and designed specifically to fit in an A4 page in order to appear brief, thus, encouraging participation (see section 3.6.2 and Appendix X and Y). This simple and innovative tool, the RecRec Task, was designed, piloted, standardized and administered in this study and can be further utilized to track progress over time in contexts where students are in their initial semester(s) of medical or EMP studies or in faculties and can be used both as a pre-task and post-task. The RecRec task provides reliable results in the UK medical context or contexts that follow similar learning and teaching resources. Specifically, it is addressing medical students who rely on English learning and teaching materials to study medicine to track their familiarity with the word form and can be replicated or repeated to examine progress over time. This innovative task was designed with the technology available at the time when the present research was conducted and it is available in the Appendix section along with suggestions for future implementation in research purposes (see Appendix X-AD). Due to its user-friendly design, reliability and accuracy of results, the generation of the RecRec is one of the methodological developments that derive from the present study and it can be beneficial for conducting future research studies in the field.

Thus far, this section presented the implications of the present study on theoretical, practical and methodological level. Specifically, the theory of learning technical and sub-technical vocabulary can be informed from evidence-based data from LETERs texts as well as texts produced by medical students in the MEDPRO and findings from the RecRec task. Such awareness can have a practical impact by means of providing sufficient evidence for developing proposals in more *systematic ways of introducing medical students to the technical and sub-technical vocabulary of their discipline through LETERs. In addition, this study expands on the methodological options available for the investigation of technical and sub-technical vocabulary in EMP by means of designing, piloting and standardising a user-friendly receptive vocabulary recognition (RecRec) tool for first year medical/EMP students introduced to the RecRec as a new methodological instrument in the area of EMP vocabulary research. It has demonstrated the learning burden that medical students face at the beginning of their medical studies, it discussed the complexity associated with writing and receptive knowledge needs.*

6.6 Suggestions for Further Study

Conducting a longitudinal study on technical and sub-technical vocabulary of first year medical students or students from different scientific fields receptive and productive vocabulary by means of utilising the RecRec or equivalent and collecting medical students' samples of writing may bring further evidence on the topic of acquisition of disciplinary vocabulary. It remains to be seen with future longitudinal studies in the field that follow students over a number of semesters or academic years and take notice of the time when transfer in receptive and productive usage of technical and sub-technical vocabulary happens. In addition to this, focusing on word knowledge from areas such as word meaning, function, multiword units (Schmitt, 2010) or syntactic and grammatical patterns may help gain more insights on the depth of vocabulary. In addition, similar studies extending on listening and speaking of disciplinary vocabulary may complement the findings of the present work.

In the area of productive vocabulary, more studies are recommended to investigate areas such as the variety of technical and sub-technical vocabulary as well as other functions of language, for instance, collocations and phraseology (Gledhill, 2000) or epistemic stance (Gablasova et al., 2017) in student corpora produced for the purposes of academic assessment. Such studies are meaningful as they may offer more insights regarding medical students' capacity to express their ideas following the conventions of the genre. If data is collected over different periods, it may be possible to observe the way(s) medical students' productive vocabulary develops over time. In addition, more studies focusing on *the transition from recognition to production are necessary in order to improve understanding in the field and make more informed decisions when it comes to expecting receptive vocabulary to become productive whether orally or in written. This goes in line with Coxhead (2021a) who claimed: "Again, the research finds noticing and recognition of vocabulary are important for learners, but the impact appears to be limited. More help is needed to help learners and teachers with moving vocabulary from recognition to production" Coxhead (2021a: p.217).*

In addition, it can be suggested that conducting corpus-based studies on frequently occurring medical vocabulary that derive from Greek or Latin roots followed by sessions raising awareness of them can be beneficial. This is because foreign-oriented vocabulary in medicine (see sections 2.4; 2.6; 4.2.1.; 4.2.2. and 5.4) has been associated with increased learning burden (Cabrita et al., 2014) and linked Graeco-Latin roots with developing awareness of the disciplinary vocabulary of medicine that derives from them. Such studies have the potential to demonstrate the extent to which familiarizing medical students with key vocabulary deriving from classical languages has an impact on the learning burden of words that derive from them.

Finally, the area of phonetics and pronunciation of medical vocabulary is an area that is under-investigated in EMP, yet claimed to be a challenging one for learners of Medical English of various linguistic backgrounds (Ferguson, 2013). A research study focusing on the development of phonological acquisition of the disciplinary vocabulary used in medicine can make it possible to provide more insights as to how students acquire the phonology of medical words and suggest strategies for more effective phonological acquisition of medical vocabulary.

6.7 Summary and Conclusion

The aim of this chapter was to provide a summary of the present research in the field of vocabulary studies in English for Medical Purposes (EMP). The limitations, implications, contribution, practical recommendations and suggestions for further study were featured in this chapter.

As part of the present research study, disciplinary vocabulary including technical and sub-technical vocabulary was investigated from the perspective of Learning and Teaching Resources (LETERs), receptive recognition and productive usage for *both L1 and L2 participants. It documented that medical students' first semester LETERs seem to have a higher lexical density of technical over sub-technical vocabulary to which students need to familiarize themselves. Findings from the Receptive Recognition Task (RecRec Task), which was designed from lexical items appearing in LETERs, suggest that by the end of the first semester medical students were familiarised with a larger number of sub-technical than technical vocabulary items. Despite the statistically significant results on the receptive vocabulary for both types of lexis, these findings were not reflected in written production. Implications as well as results from this study may be generalizable to:*

a) L1 and L2 medical students, given that no statistically significant differences were observed, and

b) to other faculties of medicine across the UK given that they abide by the standards set by the General Medical Council in Britain (Timm and Polack, 2016; GMC, 2018), which ensures an equal level of medical knowledge and practice to all training doctors in Britain.

Although the present study has limitations, as discussed in section 6.3, it is the first attempt to conduct an EMP vocabulary study in a medical context. It included more than one authentic learning and teaching materials to design an experimental receptive recognition task on real medical students who, at the time of data collection, they were trying to familiarize themselves with medical vocabulary, which was new to them. Therefore, this study contributes to gaining a better understanding of the disciplinary technical and sub-technical vocabulary density in LETERs that medical faculties suggest students to use, medical students' vocabulary gains during their initial semester, which aims to introduce them to the science, and their actual use in their productive writing. In addition, a new vocabulary research tool, the receptive recognition task (RecRec Task), was generated, piloted and standardised with a view to facilitate the purposes of the present study and is made available for future studies in the area of EMP vocabulary.

Appendix Section

Note to the Reader

Corpus-based methodology often involves long appendices, which the reader can refer to at any point. With a view to provide a deeper understanding of the stages that this research project involved, samples related to this research study are attached to it. It should be noted here that due to word limitation constraints some supplementary sections that would otherwise lead to exceeding the word count are included. In addition, a representative sample of the data included in this study are presented here. The rest of the data is secured and can be made available to the reader upon request. Finally, it is anticipated that the reader may easily follow the thesis by following the related references made in the appendix section in an effort to gain a more in-depth understanding of the nature of this research.

Appendix i: Complementary Studies on EMP Vocabulary Analysis

The field of EMP has become the epicentre of a number of linguistic studies due to its' numerous idiosyncratic features, as mentioned in section 2.1. Thus, vocabulary studies in the medical field aimed at specific vocabulary traits of the genre (e.g. Luzon-Marco, 2000; Li and Ge, 2009) as well as examine the vocabulary of medical texts in order to facilitate medical students' transition from lay to technical knowledge by means of offering preparatory courses. Studies concentrated on guiding educators to focus on the sub-technical and technical vocabulary items (Ferguson, 2013) that medical students frequently encounter when gaining medical knowledge from learning and teaching materials. It is interesting to note that although the technical type of vocabulary has been claimed to be more difficult than the sub-technical, it was the sub-technical vocabulary that received considerable research attention as regards to enhancing awareness of its' linguistic aspects (Ferguson, 2013). In the same vein, Hsu (2013; 2018) stressed the significance of becoming acquainted with the sub-technical lexical items, which is more likely to cause learning difficulties to medical students. Aiming to assist instructors of English for Medical Purposes in teaching the sub-technical vocabulary, studies have been conducted to provide guidelines for instructors as to what kind(s) of sub-technical items instructors and students should focus on first (Hsu, 2013).

However, it should be mentioned here that the sub-technical vocabulary covers not only the academic vocabulary (e.g. the Academic Word List (AWL) proposed by Coxhead (2000), but also includes higher level demanding vocabulary that is also shared amongst academic disciplines (Chung and Nation, 2003; section 2.8.3). In order to respond to this need, Coxhead and Hirsh (2007) devised the EAP Science List from a corpus of 2,637,226 running words, which resulted in the 318-item EAPSL, which, however, they did not utilize medical textbooks in their corpus compilation. The limited coverage of the AWL in specialised texts was acknowledged by both Coxhead and Hirsh (2007); it was also examined by Chen and Ge (2007) who confirmed the limited potential of the AWL to cover the corpus of 50 specialized Medical Research Articles (MRAs). Findings of their research study suggest that out of the 570 AWL items, 292 (51.2%) appeared in their MRAs corpus (Whole Paper Corpus or WPC). This suggests that half of the AWL vocabulary was reflected in the WPC. Another interesting finding resulting from *their study lies on the fact that while certain lexical items had a high frequency in the AWL, they were low frequency words in the WPC medical texts. Despite the fact that their claims were based only on the context of MRAs, this finding is meaningful suggesting a limited utility of the AWL to students of English for Medical Purposes. This led the researchers to suggest that more medical wordlists based on authentic texts should be generated. In order to respond to this need, Wang et al. (2008) created a suggestive Medical Academic Wordlist (MAWL) for learning and teaching purposes based on a corpus of 288 MRAs, totalling 1,093,011 running words. By utilizing Coxhead's (2000) corpus analysis criteria for word selection such as frequency and RANGE, they generated the Medical Academic Word List (MAWL), which consisted of 623 word families covering 12.24% of the tokens appearing in their corpus; however, a 54.9% overlap with the AWL was reported by Hsu (2013). The studies of Chen and Ge (2007) as well as Wang et al. (2008) are important and they constitute a primary effort to study medical vocabulary in authentic medical texts using the corpus analysis software (RANGE) for its investigation. Then, Hsu (2013) utilised some of the principles already followed by the authors for the purposes of research and analysis of the sub-technical vocabulary of medical textbooks (see section 2.9.1).*

In the same vein, Quero and Coxhead (2018) examined the vocabulary of two medical textbook sources compiled in the Medical Corpus (Med1 corpus). The Med1 corpus was 5,431,740 running words long and was compared with two other corpora of the same length. The second Medical Corpus (Med2) also relied on medical learning materials and the third corpus was the General English Corpus, which compiled samples from already established corpora. These were: the BROWN corpus (Kucera and Francis, 1964); the Lancaster-Oslo/ Bergen corpus (LOB) (Leech et al., 1978), the KOLHAPUR corpus (Shastri, 1986), the Australian corpus of English (ACE) (Peters et al., 1986), the Wellington corpus of written New Zealand English (WWC) (Bauer,1993), the Freiburg-LOB corpus (FLOB) (Mair and Ludwigs, 1999), the Freiburg-Brown corpus (FROWN) (Mair and Ludwigs, 1999). In addition to this, the General English corpus also included items from established vocabulary wordlists such as the AWL, the GSL, the BNC, the COCA and the EAP science list. For the lexical analysis, they conducted a corpus comparison between Med1 and the General English Corpus and their findings suggested that the coverage of Med1 on GSL, AWL and EAP science list was 56.55%. Then, the researchers limited the focus to the coverage of the first *three thousand words of the Med1 on the General English corpus, which was 21.40%. Then, another comparison between the Med1 and the Med2 was conducted in order to study the behavior of the Med1 in the 3K most frequent words. Data suggested that on the Med2 corpus the lexical coverage was down to 5.29%. It should be noted here that Quero and Coxhead's (2018) resulting wordlist of the most frequent 3.000 words is meaningful as it suggests ways in which linguistic data can be compared with large volume of textual data in order to generate reliable and useful tools that EMP instructors can utilize in their EMP classroom. The focus of this study was limited to L2 contexts with EMP students with a relatively lower level of English command. In cases when medical students do get familiar with the proposed most frequent K3 words, there is a possibility that there may be a significant number of unknown words in medical texts that impede understanding. Taking this into consideration, it can be suggested that Quero and Coxhead's (2018) vocabulary study is one of the few studies designed to address the vital needs of L2 EMP learners in English, yet it does not cover the highly specialized disciplinary language that is specifically used within the medical genre.*

Other data driven vocabulary studies focused on examining the vocabulary of the medical discipline to elements such as the slang language and technical jargon used in the hospital wards to enhance effective communication between practicing doctors (Gyuró, 2017). Data suggested that typical features of slang language include contracted forms of single words, shortening of words and syntax, usage of abbreviations, humoristic words and expressions. However, medical jargon refers to newly founded terminology as well as General English words with specialized meaning. Gyuró (2017) suggested that although practicing doctors have the capacity to express their intended meanings in lay language, they often opt the use of technical terminology in order to demonstrate supremacy and capacity to utilize intricate lexical items to express themselves. Gyuró (2017) concluded that slang language may be appropriate in written form and suggested that medical students do not actively seek to use this kind of language but look into the rationale behind each slang word or expression in Medical English.

It can be seen from studies that have been included in this chapter and specifically in the studies of Hsu (2013; 2018), Lei and Liu (2016), Quero (2017), *Quero and Coxhead (2018) that they investigated the vocabulary that medical students are introduced to in their learning and teaching materials. Yet, none of them utilised their corpora output to conduct an experiment on actual medical students who utilize the resources for their personal study. Quero's (2015) study is one of the first attempts to involve a combination of corpora applications in line with experimental findings; however, the researcher did not design a receptive task from her corpus output and used the VLT instead. The VLT is an already standardised vocabulary size test examining General English and is not specifically targeting disciplinary vocabulary. To put it differently, most studies effectively addressed the need for medical students to learn the vocabulary of their discipline from their learning and teaching resources (LETERs). The studies contributed to the field by providing a number of wordlists with the hope that they might help EMP and medical students with their learning of the specialised vocabulary be it technical or sub-technical. These studies have a legitimate existence in the area of vocabulary research since they offer the opportunity to gain a better understanding of the kind of vocabulary needed in order to study medicine. However, knowing which lexical items EMP instructors or students should prioritize is just the tip of the iceberg. This is because so far once the suggested wordlists become available there is no follow-up study to evaluate their effectiveness on actual students of EMP; nor is there a study that tracks the progress of vocabulary size of medical/EMP students over time. This is a gap in the literature that the present study intends to fulfil and the methods implemented in order to achieve this are outlined in the chapter that follows.*

Appendix ii Selection of the Type of Productive Task

Selecting an appropriate type of productive task is important in the present study. One of the options relate to the amount of prompts provided to participants in order for them to produce discourse in writing. Prompted or controlled active vocabulary task, for instance, which involves participant writing with prompts was considered. It was found by Laufer and Paribakht (1998) who conducted a research study on productive vocabulary involving a prompted task (controlled active vocabulary) and an unprompted task (free active vocabulary) that in the controlled active vocabulary subjects produced a lot more lexical items compared to the free active vocabulary task. This finding was based on a total of 79 EFL participants who took both writing tasks and suggested that the two research instruments produced different results. The researchers suggested that the reason for this difference lies on the fact that free active vocabulary involves an additional awareness of what is appropriate in a given context as well as other kinds of knowledge such as the usage of appropriate syntactico-grammatical features. Similar findings have been reported in a study conducted by Laufer (1998), which involved controlled receptive, controlled productive vocabulary and free active vocabulary task (unprompted). Findings from the first group (26 subjects) and the second group (22 subjects) suggest that the free active vocabulary, which relates to unprompted writing, did not develop as significantly as the two other testing methods, i.e. the controlled receptive and controlled productive vocabulary. This suggests that tasks requiring learners to respond to prompts were more successful. It could be possible that the type of lexical knowledge they assess is more easily accessible when prompts are provided compared to the unprompted tasks where learners have to think of an essay text on their own.

Examples of prompted tasks are Laufer and Nation's (1999) Productive Vocabulary Size Test (PVST) and Laufer and Nation's (1999) Productive Vocabulary Levels Test (PVLT). Both types of productive tests were based on controlled tasks requiring test takers to fill in blanks as in the following example:

"She has contributed a lot of money to various charities. She is known for her generosity and bene____." (Laufer and Nation, 1999:50)

In order to be accepted into the university, he had to imp___his grades.

or

Many people are inj___ in road accidents every year. (Laufer and Nation, 1999: 46-47).

Both PVLT and PVST were required to fill in the empty space with the rest of the word that matches the context of the sentence. The PVST assesses K1, K2, K3, K5, K10 and the AWL items in a fill-in the gaps task with the rest of the word. Although this type of testing makes it possible to assess vocabulary level with relative ease since only one answer is correct, it was not suitable for the purposes of the present study. This is due to the fact that it was mainly designed for learners of English with relatively low level; thus, the K10 maximum limit for vocabulary assessment may not be suitable for very advanced native speakers of English who may know more words than K10 (Brysbaert et al., 2016). In addition, Read (2000) considered this type of tests as an "alternative way of assessing receptive knowledge rather than a measure of productive ability" (2000: 126). This view was further supported by both Webb (2008) and Aviad-Levitzky et al. (2019), who claimed that the provision of the vocabulary item prompts could simply stimulate prompted answers from memory or guessed answers rather than involve productive skills. In addition, Meara (2005b) commented on the rather limited number of test items included in the PVLT. Interestingly, Nation (2004) mentioned that the vocabulary items included in the PVLT test are in line with vocabulary included in the General Service List (West, 1953), which has been considered as out-of-date (Pilar et al., 2014). Due to the reasons outlined above this vocabulary testing instrument was not selected for the present study.

Another option available online is the Computer Adaptive Test of Size and Strength CATSS (Laufer and Goldstein, 2004) as well as its' newer version, the New CATTS (Aviad-Levitzky et al. (2019), which assesses active and passive recall and recognition in productive vocabulary. Although it is an interesting test to use in order to assess size and strength, it is a bilingual Hebrew-English only test. Thus, it was not possible to utilize this instrument for the current research study due to the fact that the sample population was not familiar with Hebrew.

Another productive vocabulary assessment tool is the Lex30 by Meara and Jones's (1990) consisting of 150 lexical items. It is a controlled productive test and it requires the test taker to associate one word with another. Although Meara and Jones's (1990) Lex30 was not a word association test, it can be suggested that the mere fact that it attempted to examine the test takers' need to select an association of one word that is appropriate or collocates with another. This can make the test unclear as to what type of knowledge it targets since one may suggest that testing collocates is more associated with receptive vocabulary. A later work of Meara (2007) on the development of P-lex is a remarkable one. Specifically, P-lex works by automatically extracting 1 difficult word out of a string of 10 words in a clause or sentence and, thus, it can be ideally used to judge the degree of difficult words used in a text. However, this feature was not deemed as appropriate for the purposes of the present study. This is because the present thesis seeks to investigate to what extent technical and sub-technical vocabulary is used in medical students' writing and in order to achieve this, the produced vocabulary of a written text needs to be classified in these two categories. In addition, it has been claimed that medical students encounter one difficult/unknown word in every three words in medical textbooks such as anatomy (Chung and Nation, 2003), thus if the P-lex tool that finds one difficult word out of ten, it may not be suitable in this particular thesis.

Another way to assess productive vocabulary relates to the vocabulary profiles needed to be examined in a vocabulary analysis tool, which is up-to-date and can extrinsically measure vocabulary. One such online lexical profiling tool is the Compleat VocabProfiler (VP) platform available online at <http://www.lextutor.ca/>. The VP is an online corpus analysis platform that Higginbotham and Reid (2019), Booth (2021a) and Schmitt (2021) considered as the most up-to-date lexical profiling tool used to investigate lexical sophistication in texts at the time of the present research. In this study, it was considered that submitted academic medical essays, where students were expected to demonstrate disciplinary knowledge and expression in order to fulfil the purposes of their coursework assessment, seemed to be an appropriate source of examining productive vocabulary usage for the purposes of the present study. The type of essay used to measure medical students' productive use was an argumentative academic essay. It required medical students to discuss the case of a medical student in the form of case study. The topic was about mental health *and specifically on depression. Medical students would read a patient's history record and they would need to generate evidence-based arguments demonstrating advanced knowledge of complex neurophysiological processes that affect depression. They were asked to rationalise their diagnosis and discuss treatment options. Their essay arguments would have to be in line with up-to-date literature on the topic and their word limit was 1,400 words. While depression is a topic that has been discussed in other genres such as psychology, sociology and literature. While students might present a tendency to express themselves following the genre and expression of the specialised vocabulary adopted in published materials on depression from these disciplines, it was made clear in the assignment question that medical students had to adopt the pattern of vocabulary, style and expression followed in medical journals. In addition to this, specialised vocabulary was further encouraged by the addition of extra marks for students who would enrich their essays with the specialised vocabulary of the discipline. Subjects' attention when writing the essay was geared towards their academic assessment by means of demonstrating their scientific knowledge and focusing on the information included in the essay. This made the submitted essay an ideal source of authentic student data since the bias of participating in a linguistic study was eliminated and their focus was to communicate scientific information to their audience, which was what their essay examiners expected. In addition, most medical students in the faculty where the present study took place were high achievers and had limited time to dedicate for their participation in this study. Therefore, medical students written essays, later renamed as productive tasks, were considered as appropriate for the productive vocabulary process of data collection.*

The essay topic and the genre had a significant impact in the type of disciplinary vocabulary used in the productive tasks. Specifically a mental health topic, although written from a clinical perspective, might not involve as many anatomical references as a topic related to a musculoskeletal issue, for example. Thus, it was expected that the vocabulary used in the essay might not involve highly specialised terminology due to its' complex nature with other sciences such as psychology or sociology. To put it differently, an acceptable essay on the topic of depression might use less specialised vocabulary and, yet, be acceptable while a topic on a more narrow area of the medical field might have required *specialised vocabulary of the field in order to discuss its arguments in an appropriate way.*

Appendix iii: Identification of MEDREC Language Data Source(s) on the LETERs Wordlist

This section aims to discuss a complementary procedure that followed the lexical coverage analysis output: the identification of the source(s) where each word appearing in the LETERs lexical coverage wordlist came from. As mentioned in the previous section 3.6.3, the lexical coverage analysis on MEDREC and its' resulting wordlist was unable to provide details as regards to the data sources of word items from the output. Thus, it was challenging to explain the high/low degree of frequency and the range score of each of the 38,713 tokens without looking at the bigger picture of how many times and which of the six LETERs it appeared. Specifically, when the range score was above one, it was unclear which compiled source included the item and whether the frequency of repetition was higher or lower in each of the compiled sources. Whether a token repeated in one or multiple sources could not be examined through a lexical coverage analysis data. To increase interpretation of the findings from the lexical coverage output, careful examination of each token origin in an additional analysis of the context(s) where each token came from (see Appendix W). In addition to this, awareness of the sources of input was expected to inform on the context where students were most likely to encounter their technical and sub-technical word items. For instance, tokens from lecture presentations would most probably be encountered in a lecture room where a lecturer shared medical information with the students while the e-learning materials, pips, computer practicals and textbooks were most likely encountered during students' personal study during the term (see sections 3.4.1-3.4.5).

Upon running the LETERs wordlist together with each of the six compiled resources included in the MEDREC on the RANGE software, a colour coding of the summative data presented in Appendix W eased the process of identification of the sources of input by the researcher, who coded the source in which every token belonged. In line with other researchers such as Hsu (2013; 2018), all corpora outputs were entered into an Excel file and were colour coded based on at least one corpus source that they came from. The Excel package during this process assisted in sorting out the data and giving them colour codes, thus facilitating the analysis of each sub-corpus source(s) word identification through colour coding. The example data from Appendix W, suggest that the vocabulary item:

amothericin is present in three sources compiled on the MEDREC corpus (thus, its range was 3 on the left) and its frequency was 119 in the MEDREC corpus. Then, by using an excel file, the data was coded as it appears in Appendix W. In the case when a token was present in more than one sources, both cells were colour coded as it appears in Appendix W. Specifically, the word amothericin (Appendix W) appeared in two LETERs resources: 9 times in the computer practicals sub-corpus and a lot more times (109 times) in the e-learning materials sub-corpus and once on SCALPEL. What can be understood from the identification of the source(s) on the LETERs wordlist is that a balanced variety of language input on medical students seems to be introduced to learners though LETERs in this example. This suggests that medical students could have the potential to encounter some disciplinary vocabulary items in more than one resource, thus, increasing the chances for incidental learning. Upon gaining additional information from the LETERs wordlist beyond the automated output analysis report, the process of selection of technical and sub-technical vocabulary from the data was performed, as discussed in the following section.

Appendix iv: The RecRec Task Scores Adjustment Algorithm

As discussed in the previous section, in order to increase reliability of the RecRec, which follows the Yes/No testing style (see section 3.6.7.1), a number of imaginary words or pseudowords, i.e. words that appear similar to word items of the target language (Zimmerman et al., 1977; Anderson and Freebody, 1983), were included in the RecRec task. The rationale for using imaginary words lies in the fact that test takers who did not respond attentively in the RecRec Task would have their final RecRec scores re-calculated. Currently, there are two explanations to justify the test takers' ticking of the imaginary word items. The first is that learners simply made a guess or had the assumption that they know the item. In the testing literature a guessing based on chance is often considered as a sophisticated one and it is acceptable (i.e. judging the meaning of a word based on cues) (Anderson and Freebody, 1983). The second reason why a test taker may select imaginary words has to do with personality factors. This means that the degree of estimation, overestimation or underestimation of their knowledge may affect responses (Nunnally and Bernstein, 1994). This will be apparent in their responses to imaginary words since overestimation of their knowledge of vocabulary may lead them to think that they know the imaginary words (Huibregtse et al., 2002) while underestimation of their knowledge may lead to less responses to imaginary word items.

On the other hand, in cases when students who do tick on all real words and leave the imaginary words blank, they will have no adjustments to their final score (Meara and Buxton, 1987). However, in cases when individuals ticked on the imaginary words, scores amendments to the final RecRec score were necessary (Pellicer-Sanchez and Schmitt, 2012). In the literature of yes/no test development, four formulas were suggested by researchers. Depending on a variety of factors taken into consideration, there are four ways to measure the score in the Yes/No test (Huibregtse et al., 2002), which are going to be discussed in this section.

In order to amend the test-takers scores, a number of factors needs to be considered. For instance, in a yes/no test with imaginary words present, it is necessary to consider four aspects. These were a) the number of "hits" (H), which relate to students' answering yes to a real word in English, b) the number of "false alarms", (FA) when students tick yes to imaginary words, c) the "misses", *when students did not tick on real words, and d) "correct rejections" when students correctly left the imaginary words blank (Pellicer-Sanchez and Schmitt, 2012:3).*

The factors described above were adjusted with a number of formulas that have been proposed so far to be able to calculate the final score by means of subtracting the total of false alarms (FA) from the total number of hits (H). The formula:

$H\text{-}FA$

has been used to subtract the imaginary words from the real words. However, this formula was considered "too simplistic" (Pellicer-Sanchez and Schmitt, 2012:3).

Another theory such as the Signal Detection Theory by Green and Swets (1966) and Zimmerman et al. (1977) aimed to provide a reliable method of measuring the FA in a lexical test by enhancing participants' recognition by means of signals. The Signal Detection Theory laid the foundation for Anderson and Freebody (1983) to introduce the following formula:

$cfg = [P(H) - P(FA)] / [1 - P(FA)]$

This formula has been following a tradition of multiple choice test correction and was named as the Correction for Guessing formula (cfg). In addition, it has been claimed that this formula is more sensitive to the hit rate (H) rather than the false alarm (FA) rate (Huibregtse et al., 2002). Moreover, based on the Signal Detection Theory another formula was suggested by Meara et al. (1994) based on the amount of guessing that test takers make. This formula has been called the 'delta m' (Δm) or 'Meara's Δm' (Huibregtse et al., 2002).

$\Delta m = [(H - FA)/ (1 - FA)] - (1 I H)$

A critical comparison of all the three methods suggested including the Δm by Huibregtse et al. (2002) concluded that the Δm was sensitive to the participants' guesses but unable to observe the kinds of testees' reactions to the word stimuli. Moreover, the cfg was underestimating the FA compared to the Hits. This led them to suggest a new formula that included both features, the Isdt:

Isdt = I -[[4H(I -FA)] - [2(H -FA) (I +H -FA)]] I [[4H(I -FA)] - [(H - FA)(1 +H-FA)]]

It is interesting to note here that the Isdt formula was often yielding findings with minor differences to the formula H-FA. Based on comparisons between the three existing formulas available for marking the yes/no tests concluded that the Isdt method was suggestive for marking these type of tests as this formula claims a more accurate calculation of the proportion of Hits against FAs according to Huibregtse et al. (2002).

A comparative study by Mochida and Harrington (2006) on the yes/no tests for marking the Vocabulary Levels Test (VLT) utilized the four proposed scoring methods concluding that there are minor differences between the scores documented. They stressed the role of the number of hits, which according to them it has the propensity to determine the overall score. Similarly to Huibregtse et al. (2002) they found less difference between the H-FA and the Isdt leading them to recommend the H-FA when scoring yes/no tests in informal situations but they did not recommend it for research purposes.

Another example of a comparative study of the suggestive scoring methods to yes/no test was conducted by Beeckmans et al. (2001) in the field of teaching French to speakers whose first language is Dutch. The researchers aimed to observe the degree of variability of test results of the yes/no test using the scoring algorithms presented above and concluded that each of them tended to yield different scores.

Another factor that was considered as significant in this type of tests is the students' Reaction Time (RT), which was first suggested by Meara (1994). By means of grouping words from different frequency levels, he gave the same battery of words to both L1 and L2 speakers of English measuring their Reaction Times as well as the accuracy of their responses. Developments in technology may make the RT suggestion possible however at the time when this research was published, this method could not be implemented with the technology that was available at that time as small RT differences could not be easily documented leading to significant problems in the comparison of the RTs between groups of test takers.

More research from Harrington and Carey (2009) who, upon conducting a comparative study of the four available formulas for marking yes/no tests, they concluded that there is a lack of consensus between researchers as to which formula is best to mark the yes/no tests. They suggested that the test takers' Response Time RT (Meara, 1994) to each item may be the way towards gaining more accurate findings in the yes/no tests.

This led Pellicer-Sanchez and Schmitt (2012) to conduct their comparative study considering all four formulas (H-FA, cfg, Δm, Isdt) and used current computer assistive testing to measure the test takers' Reaction Time (RT). In addition, they conducted interviews to confirm the testees' lexical knowledge. Taken that the quicker the response, the more accurate it would be, and the later the response, the less accurate it may be, their study compared all four algorythms against the Reaction Time (RT) approach. Findings of their study suggest that the results from students' Reaction Times (RT) were not as efficient in measuring the testees' familiarity with lexical items on the receptive level. This is because test takers with lower proficiency level were expected to tick the FAs anyway, thus RT was a redundant strategy. Another reason lies in the test takers' tendency to misjudge their responses by ticking the FAs regardless of the RT, leading the RT towards a loss of sensitivity as an adjusting factor on the scores of test takers who had the FA ticked. This led the researchers to conclude that the FA are necessary in a yes/no test design since: the more someone is overestimating his or her knowledge of the words being assessed, the greater the chances that he or she would overestimate it in the case of imaginary words. Thus, in the case of higher FA rate, the more overestimation and the larger the amount of scores "adjusting" that needs to be done, at which point the RT approach stops being as effective (Pellicer-Sanchez and Schmitt, 2012 p.15). Considering that so far there is still no agreement as to which of the four proposed formulas for testing the yes/no tests is most appropriate, they decided to use different formulas to calculate different FA rates. Specifically, they applied the Isdt formula when the total number of false alarms (FA) was FA=8 or above while the H-FA formula was used when the number of FAs was between 2 and 7.

In order to fulfil the purposes of this study, the students' Reaction Time (RT) was impossible to be measured on a large number of students who were given their test on a printed version at the time when they took the task. Except for this, the

RT approach was found not to produce significant statistical difference from the other four methods outlined in this section. The four suggestive formulas in this section were piloted in order to observe their behavior on a sample of three examples of extreme values, which were examined for the process of selection of the formula to be used for the purposes of this study (see Appendix T).

From the examples demonstrated in Appendix T, all formulas (H-FA, cfg, Δm, Isdt) seemed to work well and often produced similar or different findings. In order to select the ideal formula for the purposes of this study, the following aspects were considered: the amount of correct Hits and the amount of False Alarms. In addition, another aspect that was maintained by Huibregtse et al. (2002) relates to the acknowledgement of correct rejections, which is possible to be observed from the amount of unticked FAs.

It should be mentioned here that while it appears that the Isdt formula has the propensity to give similar scores with the H-FA formula, especially when the number of False Alarms grows larger, the H-FA fails to take into account the correct rejections. Thus, when the FA is low, the Isdt will calculate the correct rejections and give credit to the student. As far as the Δm is concerned, its' score given tends to be low in most cases underestimating the performance of the test taker. As regards to the cfg formula, it tends to be giving significantly higher scores when the proportion of hits increases even in cases when the amount of non-words ticked is significantly raised.

The Isdt method was proposed by Huibregtse et al. (2002) was considered as ideal for marking the RecRec tasks in this study. This is because it has the capacity to detect the response style of the individual participants who may either underestimate their knowledge by limiting the amount of hits and non-words or overestimating their knowledge by doing the opposite. Another advantage of this formula is its' practicality, ease of adjusting the scores and accuracy. On the other hand, one of the disadvantages of the Isdt formula is that it fails to take into account the word frequency and range as it is set to test real from imaginary words, which appear as real. However, this does not seem to affect this study since it is based on lexical coverage, which determines the words to be selected for the RecRec task. Therefore, for the purposes of this study, an overall score as *well as a more extensive study of the lexical bands frequency results based on participants' responses to the RecRec task was calculated for each band level.*

Appendix A Grade Descriptors on Presentation, Coherence and Clarity

BM5 Year 1 FoM Assignment Grade Descriptors 201314

		Presentation, coherence & clarity – 20% weighting
80-100%	Excellent	• Excellent and clear structure with effective and appropriate use of subheadings and paragraphs • Use of clear and relevant diagrams figures & tables with full clear legends if appropriate • Excellent grammar and syntax with use of appropriate terminology and minimal spelling mistakes • Excellent use of scientific writing style
65-79%	Very Good	• Evidence of clear structure and good use of subheadings and paragraphs • Use of clear and relevant diagrams, figures & tables with good legends if appropriate • Good use of syntax, grammar and appropriate terminology with few spelling mistakes • Good use of scientific writing style
50-64%	Good	• Discernable structure with evidence of appropriate use of headings and paragraphs • Satisfactory use of diagrams, figures and tables with legends if appropriate • Generally grammatically sound with some use of appropriate terminology, occasional spelling mistakes • Satisfactory use of scientific writing style
40-49%	Fair	• Limited evidence of structure or use of paragraphs • Limited use of diagrams & tables with inadequate legends • Some grammatical error with limited sentence construction, spelling mistakes and use of terminology • Limited use of scientific writing style
25-39%	Poor	• Little evidence of structure • Poor use of diagrams & tables with inadequate legends • Contains many grammatical and spelling errors, poor syntax with inaccurate use of terminology • Poor use of scientific writing style
0-24%	Very Poor	• No clear structure • Inappropriate diagrams, figures and tables • Unacceptable grammar, spelling and syntax with inappropriate use of terminology • Inappropriate use of scientific writing style

Appendix B Appendix B: Pilot Study

Title: Technical and sub-technical vocabulary correlation in introductory chapter in 4 sample medical textbooks

Background: *Most medical textbooks to date include one introductory chapter which provides an overview of the follow-up chapters, chapters which typically focus on a specific part of the body/function each and usually there's no conclusion in them.*

Aim*: This study aims to provide a direction as to which part(s) of medical textbooks concentrate most of the vocabulary included throughout the book.*

Hypothesis: *It is hypothesised that the introductory chapters concentrate most of the vocabulary that is encountered in the follow-up chapters.*

Methods: *A brief note on the methods followed to conduct the correlation of technical-sub-technical lexis between introductory and book chapters (in steps)*

Step 1: *selecting sufficient samples to test the hypothesis on whether the vocabulary introduced in a medical text is repeated in the chapters that follow (The Pilot Corpus consisting of 428,486 running words).*

Four medical textbooks were randomly chosen for this pilot study. The introductory chapters and three random chapters from the same book were tested on the extent to which the vocabulary is recycled in the introduction and main chapters. The textbook materials used for this study were the following:

Table 26: Pilot Corpus Samples.

Book	Title	Intro ch In Running words	1st Sample Ch. in running words	2nd Sample Ch. In Running words	3rd Sample Ch. In Running words
1	*Neal, M., J. 2009: (7th Eds.) Medical Pharmacology at a glance. Willey Blackwell.*	*41546*	*7716*	*8437*	*6804*
2	*Barret, K., Brooks, H., Boitano, S., Barman, S. 2012: (23rd eds.)Ganong's Review of medical physiology. McGraw Hill.*	*41552*	*51784*	*102357*	*59071*
3	*Lanham-New, S., A., Macdonald, I., A., Roche, H., M. 2011: (2nd eds.) Nutrition and Metabolism. Willy-Blackwell.*	*4515*	*21254*	*18069*	*14544*
4	*Waller, D., G., Sampson, A., P., Renwick, A., G., Hillier, K. 2014: Medical Pharmacology and Therapeutics (4rd eds). Elsevier.*	*14226*	*16916*	*11483*	*8222*
	Total Running Words of the Test Corpus: **428,486**				

Step 2: *selecting (and editing) the texts*

Every possible effort was given to digitise the texts. As I copied-pasted the pages on my word program I had to deal with a number of challenging features appearing in them prior to compiling the texts in the Pilot corpus. These were:

a) codes such as &40406; were in between the words of the text.
b) dashes in the middle of some words (-)
c) words missing letters e.g. the word "e ect" for "effect"

Similar scanning errors were discussed in section 3.3.1. These problems were very frequently occurring; for instance, in a text of 5,000 running words, there would be approximately 200 problems to fix which required manual intervention from the part of the researcher. Upon editing and correcting the scanned text, the text compiled in the Pilot Corpus and it had the same spelling as the original text from the textbook.

Step 3: *preparing the texts and the software*

In order for the corpus analysis software to run effectively, all texts were converted into .txt format and were given a special code so that the researcher could identify them, such as Book 1,2,3,4.

Step 4: *Running the software*

The RANGE software was used to run the pilot study's analysis which showed how many times each word appeared in a text (word frequency) as well as in how many text samples it covered (word range) in line with Hsu (2013) who conducted a similar study.

Then, the RANGE software was ran including one file from an introductory chapter and only one sample from the rest of the chapters. All statistical outputs were saved for further analysis.

Step 5: *Analysing the data*

Files were worked out in .xls and were moved into an excel spreadsheet for further analysis.

Lexical items appearing in the corpus output which had the range value "1" were discarded because this meant that they appeared only in one source but not the other. Lexis that was appearing in both texts (had the value of "2" on the range program) was further examined.

Upon isolating the words with the value "2" on RANGE output, the finding was converted into a percentage by considering the total amount of technical and sub-technical lexis appearing in each text to the amount that was similar among the two texts.

The same process was repeated for all four book samples included in the pilot study (three times for each book=9 times in total).

Step 6 Findings*:*

Table 25: Pilot Corpus Samples. demonstrates the findings from the lexical correlation between random medical chapters and their introductory paragraphs. For instance, in Book 2, random chapter 2a seems to have a similar lexis with its' introductory chapter on the 60.38% level while Book 2's introduction includes 84.34% of the technical and sub-technical vocabulary included in the random chapter a. The reason why percentages within the same correlation vary are due to the variability of the total number of that each chapter (introduction and random chapter a) has.

Step 7 *conclusions (brief)*

It appears that:

- *Different chapters appearing in medical textbooks tend to discuss different concepts. Therefore, the vocabulary that is included in medical textbooks tends to differ from chapter to chapter.*
- *The most frequent vocabulary occurring in all these texts was the BNC1 (the very basic English) and the second most frequent vocabulary was the one that was technical-sub-technical lexis, which is an interesting preliminary conclusion to keep in mind at this stage.*

There seems to be some significant correlation in the technical and sub-technical tokens between introductory chapters and the samples included in this study. They not only appeared once but tended to be repeated often quite many times as well as shown in Table 25: Pilot Corpus Samples.

Table28: Pilot Corpus vocabulary Correlation Findings

Pilot Book 1		**tech&sub correlation**
1a	*intro*	*35.09%*
	1a	*27.18%*
1b	*intro*	*71.26%*
	1b	*170%*
1c	*intro*	*41.10%*
	1c	*58.90%*
AVERAGE		*67.26%*

Pilot Book 2		**tech&sub correlation**
2a	*intro*	*84.34%*
	2a	*60.38%*
2b	*intro*	*157.00%*
	2b	*303%*
2c	*intro*	*111.77%*
	2c	*100.64%*
AVERAGE		*136.12%*

Pilot Book 3		**tech&sub correlation**
3a	*intro*	*529%*
	3a	*110.75%*
3b	*intro*	*650.65%*
	3b	*206.82%*
3c	*intro*	*1136%*
	3c	*86%*
AVERAGE		*453%*

Pilot Book 4		**tech&sub correlation**
4a	*intro*	*44.20%*
	4a	*26.20%*
4b	*intro*	*51.70%*
	4b	*95.20%*
4c	*intro*	*56.40%*
	4c	*4726%*
AVERAGE		*833.28%*

The hypothesis that was initially made in the present pilot study that the technical and sub-technical vocabulary is reflected in most medical textbook samples included in the present pilot study was confirmed since it appears that the technical and sub-technical vocabulary that is used in them were reflected in the introductory chapter. Findings from this pilot study aim to facilitate the selection of textual samples for the Textbooks Sub-corpus (see section The Textbook **Sub-corpus (TS)**

Appendix C Medical Students' Suggested Bibliography

Summary of the corpus compilation from textbook and e-learning materials (in running words)

The Textbook Corpus

Book	Title	Running Words
Book 1	Alberts, B., Bray, D., Hopkin, K., Johnson, A., Lewis, J., Raff, M., Roberts, K., Walter, P. 2014: (4th eds.) Essential Cell Biology. Garland Science.	38,555
Book 2	Russel, A. 2009: The social basis of medicine. Wiley-Blackwell.	9,967
book 3	Gibney, M., J., Lanham-New, S., A., Cassidy, A., Vorster, H., H. 2009: Introduction to human nutrition. Wiley Blackwell.	19,910
book 4	Ford, M., J., Hennessey, I., Japp, A. 2000: *Introduction to clinical examination*. Elsevier.	2,527
book 5	Hall, J., E., Guiton, A., C. 2011: (12th eds.) Textbook of Medical Physiology. Saunders Elsevier.	12,757
book 6	Sadler, T., W. 2012: (12th Eds.) Langman's medical embryology. Wolters Kluwer.	16,915
book 7	Kumar, P., Clark, M. 2012: (8th Eds.) Clinical Medicine. Saunders.	34,026
Book 8	Rhoades, R., A., Bell, D., R. 2013: Medical Physiology. Principles for Clinical Medicine. Wolters Kluwer and Lippincott Williams and Wilkins	74,934
Book 9	Wood, P. 2011: (3rd eds.) understanding immunology. Pearson.	11,274
Book 10	Lapham, R., Agar, H. 2009: (3rd Eds.) Drug calculations for nurses. Hodder Arnold.	9,138
Book 11	Lanham-New, S., A., Macdonald, I., A., Roche, H., M. 2011: (2nd eds.) Nutrition and Metabolism. Willy-Blackwell.	25,465
Book 12	Neal, M., J. 2009: (7th Eds.) Medical Pharmacology at a glance. Willey Blackwell.	1,741
Book 13	Barret, K., Brooks, H., Boitano, S., Barman, S. 2012: (23rd eds.) Ganong's Review of medical physiology. McGraw Hill.	41,488

Book 14	Ward, J., P., T., Linden, W., A. 2013: (3rd eds.) Physiology at a glance. Willey Blackwell.	7445
Book 15	Ayers, S., Baum, S., McManus, C., Newman, S., Wallston, K., Weinman, J., West, R. 2007: Cambridge handbook of psychology, health and medicine. Cambridge University Press.	67792
Book 16	Daly, L., E., Bourke, G., J. (5th eds.) Interpretation and uses of medical statistics. Blackwell Science.	18,908
Book 17	Coggon, D. 2003: (2nd eds.) Statistics in clinical practice. BMJ Books.	2,812
Book 18	Sheridan, M., D., Frost, M., Sharma, A. 1997: From birth to five years: children's developmental progress. Routledge.	2,409
Book 19	Elia, M., Ljungqvist, O., Stratton, R., J., Lanham-New, S., A. 2013: (2nd eds) Clinical Nutrition. Wiley Blackwell.	27,545
Book 20	Gibney, M., J., Margetts, B., M., Kearney, J., M. 2004: Public health nutrition. Blackwell Publishing.	21,350
Book 21	Moore, K., L., Calley, A., F., Agur, A., M., R. 2014 (6th eds.) Clinically oriented anatomy. Wolters Kluwer.	40,078
Book 22	Waller, D., G., Sampson, A., P., Renwick, A., G., Hillier, K. 2014: Medical Pharmacology and Therapeutics (4rd eds). Elsevier.	24,798
Book 23	Naish, J., Revest, P., Syndercombe-Court, D., 2014: Medical Sciences. Saunders Elsevier.	50,717
Book 24	Baynes, J., W., Dominiczak, M., H. 2014: Medical biochemistry. (4th eds) Saunders Elsevier.	28,697
Book 25	Mitchell, B., Sharma, R. 2009: Embryology: an illustrated colour text. Churchill Livingstone	3,831
Book 26	Ovalle, W., K., Nahirney, P., C. 2013: Netter's histology. Elsevier	15,900
Book 27	Rang, H., P. and Dale, M., M., Ritter, J., Flower, R. 2011: Rang and Dale's Pharmacology (7th eds.) Churchil Livingstone.	53,649
Book 28	Boron, W., F., Boulpaep, E., L. 2009: Medical Physiology. Elsevier Saunders.	65,066
Book 29	Rubin, R., Strayer, D., S. 2011: Rubin's Pathology (6th eds.) Williams and Wilkins.	66394
Book 30	Underwood, J., C., E., Cross, S., S. 2009: General and Systematic Pathology (5th eds.). Churchill Livingstone.	34,958
Book 31	Harvey, R., Ferrier, D. 2010: Biochemistry (Lippincott's Review Series) (5th eds.) Lippincott Williams and Wilkins.	23,709

Book 32	Golan, D., E., Tashijian, A., H., Armstrong, E., J., Armstrong, A., A., W. 2011: Principles of pharmacology: the pathophysiologic basis of drug therapy (3rd eds.). Lippincott Williams and Wilkins.	19,302
Book 33	Donaldson, L., J., Scally, G. 2009: Donaldson's essential public health. Petroc Press.	18,186
Book 34	Fletcher, R., H., Fletcher, S., W. 2013: Clinical Epidemiology. Lippincott Williams and Wilkins.	8,494
Book 35	Russel, L. 2014: Sociology for health professionals. Sage.	7536
Book 36	Read, A., Donnai, D. 2011: New Clinical Genetics (2ns eds). Scion Publishing.	19,273
	Total Running Words :	**927,546**

The Online Resources Corpus

Source
Running Words

PiPs (all)	71966
Power Point Presentations (all)	206025
Tutorial notes and assignment resources (all)	16686
SCALPEL (only the FoM materials)	7942
e-learning resources (all)	867462

Total Running Words:
1170081

Summary

The Textbook Corpus : 927,546

The Online Resources Corpus : 1170081

Total n. of reported running words: 2,097,627

Total n. of words reported by Range Corpus Analysis software: 2,072,293.

Appendix D   Sample Scanned Pages from Medical Textbook

Source : Moore, K., L., Calley, A., F., Agur, A., M., R. 2014 (6th eds.) Clinically oriented anatomy. Wolters Kluwer.

822   Chapter 7 · Head

OVERVIEW OF HEAD

The **head** is the superior part of the body that is attached to the trunk by the neck. It is the control and communications center as well as the "loading dock" for the body. It houses the brain; therefore, it is the site of our consciousness: ideas, creativity, imagination, responses, decision making, and memory. It includes special sensory receivers (eyes, ears, mouth, and nose), broadcast devices for voice and expression, and portals for the intake of fuel (food), water, and oxygen and the exhaust of carbon dioxide.

The head consists of the *brain* and its protective coverings (cranial vault and meninges), the *ears*, and the *face*. The face includes openings and passageways, with lubricating glands and valves (seals) to close some of them, the masticatory (chewing) devices, and the orbits that house the visual apparatus. The face also provides our identity as individuals. Disease, malformation, or trauma of structures in the head form the bases of many specialties, including dentistry, maxillofacial surgery, neurology, neuroradiology, neurosurgery, ophthalmology, oral surgery, otology, rhinology, and psychiatry.

CRANIUM

The **cranium** (skull[1]) is the skeleton of the head (Fig. 7.1A). A series of bones form its two parts, the neurocranium and viscerocranium (Fig. 7.1B). The **neurocranium** is the bony case of the brain and its membranous coverings, the cranial meninges. It also contains proximal parts of the cranial nerves and the vasculature of the brain. The neurocranium in adults is formed by a series of eight bones: four singular bones centered on the midline (*frontal, ethmoidal, sphenoidal,* and *occipital*), and two sets of bones occurring as bilateral pairs (*temporal* and *parietal*) (Figs. 7.1A, 7.2A, and 7.3).

The *neurocranium* has a dome-like roof, the **calvaria** (skullcap), and a floor or **cranial base** (basicranium). The bones forming the *calvaria* are primarily flat bones (frontal, parietal, and occipital; see Fig. 7.8A) formed by intramembranous ossification of head mesenchyme from the neural crest. The bones contributing to the *cranial base* are primarily irregular bones with substantial flat portions (sphenoidal and temporal) formed by endochondral ossification of cartilage (*chondrocranium*) or from more than one type of ossification. The *ethmoid bone* is an irregular bone that makes a relatively minor midline contribution to the neurocranium but is primarily part of the [...] cranium (see Fig. 7.7A). The so-called flat bone[...] portions of the bones forming the neurocrani[...] ally curved, with convex external and conca[...] surfaces.

Most calvarial bones are united by fibrous [...] **sutures** (Fig. 7.1A & B); however, during child[...] bones (sphenoid and occipital) are united by hya[...] lage (**synchondroses**). The spinal cord is conti[...] the brain through the *foramen magnum*, a large op[...] the cranial base (Fig. 7.1C).

The **viscerocranium** (*facial skeleton*) compr[...] facial bones that mainly develop in the mesenchy[...] embryonic pharyngeal arches (Moore et al., 201[...] cerocranium forms the anterior part of the cranium [...] sists of the bones surrounding the mouth (upper [...] jaws), nose/nasal cavity, and most of the *orbits* (eye[...] or orbital cavities) (Figs. 7.2 and 7.3).

The *viscerocranium* consists of 15 irregular bo[...] gular bones centered on or lying in the midline [...] *ethmoid*, and *vomer*), and 6 bones occurring as bila[...] (*maxillae; inferior nasal conchae,* and *zygomatic* [...] *nasal*, and *lacrimal bones*) (Figs. 7.1A and 7.4A). The [...] lae and mandible house the teeth—that is, they p[...] sockets and supporting bone for the maxillary and [...] lar teeth. The *maxillae* contribute the greatest p[...] upper facial skeleton, forming the skeleton of the [...] which is fixed to the cranial base. The mandible [...] skeleton of the lower jaw, which is movable becaus[...] lates with the cranial base at the *temporomandibu[...]* (Figs. 7.1A and 7.2).

Several bones of the cranium (frontal, tempor[...] noid, and ethmoid bones) are **pneumatized** bones[...] contain **air spaces** (*air cells or large sinuses*), pres[...] decrease their weight (Fig. 7.5). The total volume o[...] spaces in these bones increases with age.

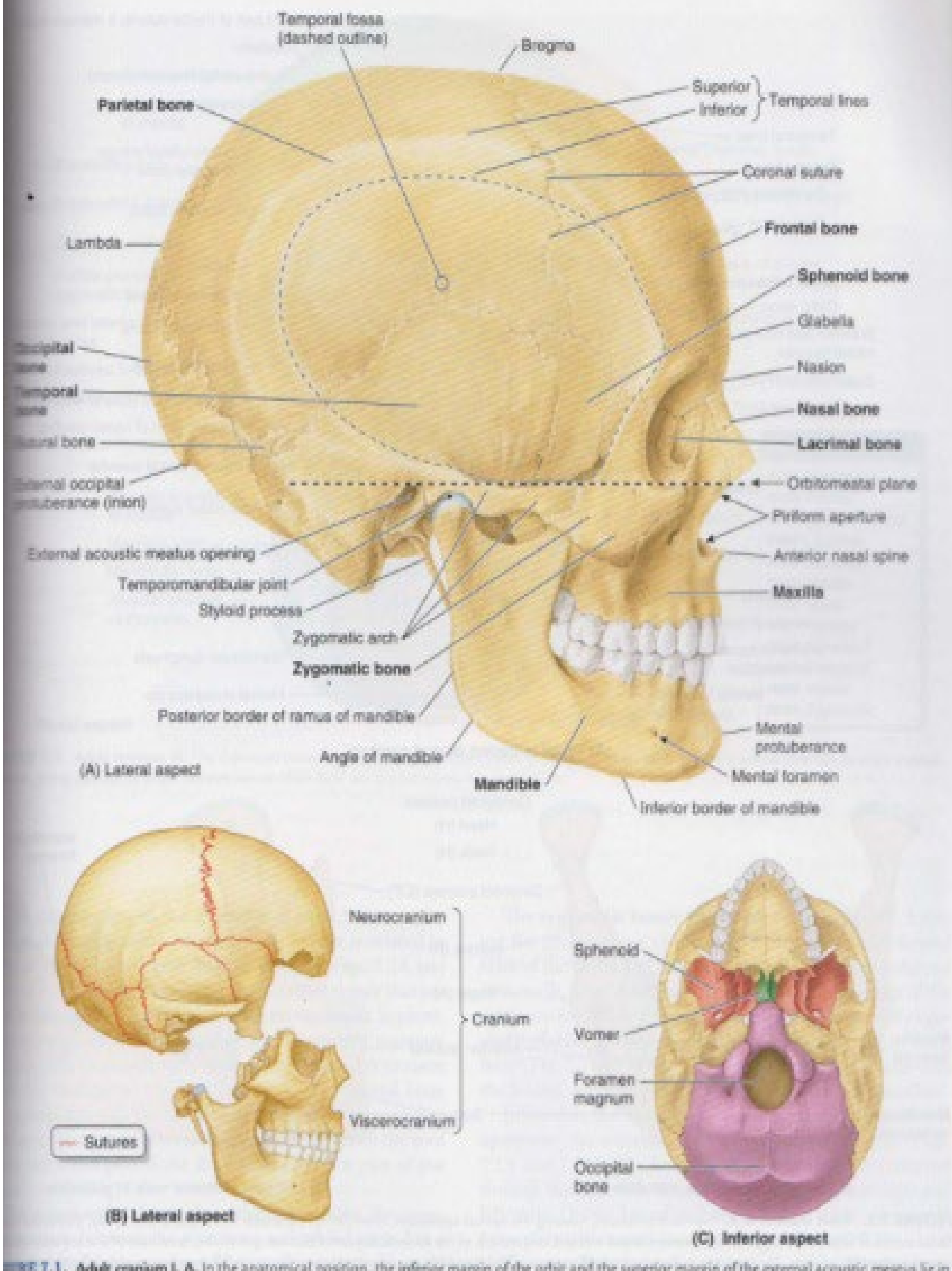
In the *anatomical position*, the cranium is oriente[...] the inferior margin of the orbit and the superior [...] the external acoustic opening of the external acoustic [...] of both sides lie in the same horizontal plane (Fig. 7.[...] standard craniometric reference is the **orbitomeatal** [...] (Frankfort horizontal plane).

Facial Aspect of Cranium

Features of the anterior or **facial** (**frontal**) aspec[...] **cranium** are the frontal and zygomatic bones, orbi[...] region, maxillae, and mandible (Figs. 7.2 and 7.3).

The **frontal bone,** specifically its **squamous** (fla[...] forms the skeleton of the forehead, articulating [...] with the nasal and zygomatic bones. In some adults [...] *suture* persists; this remnant is called a **metopic** sutu[...] in the middle of the **glabella**, the smooth, slightly de[...] area between the superciliary arches. The **frontal** [...] divides the frontal bones of the fetal cranium (see [...] box "Development of Cranium," p. 839).

[1]There is confusion about exactly what the term *skull* means. It may mean the cranium (which includes the mandible), or the part of the cranium excluding the mandible. There has also been confusion because some people have used the term *cranium* for only the neurocranium. The Federative International Committee on Anatomical Terminology (FICAT) has decided to follow the Latin term *cranium* for the skeleton of the head.



RE 7.1. **Adult cranium I. A.** In the anatomical position, the inferior margin of the orbit and the superior margin of the external acoustic meatus lie in me horizontal orbitomeatal (Frankfort horizontal) plane. **B.** The neurocranium and viscerocranium are the two primary functional parts of the cranium. e lateral aspect, it is apparent that the volume of the neurocranium, housing the brain, is approximately double that of the viscerocranium. **C.** The red sphenoid and occipital bones make substantial contributions to the cranial base. The spinal cord is continuous with the brain through the foramen gnum, the large opening in the basal part of the occipital bone.

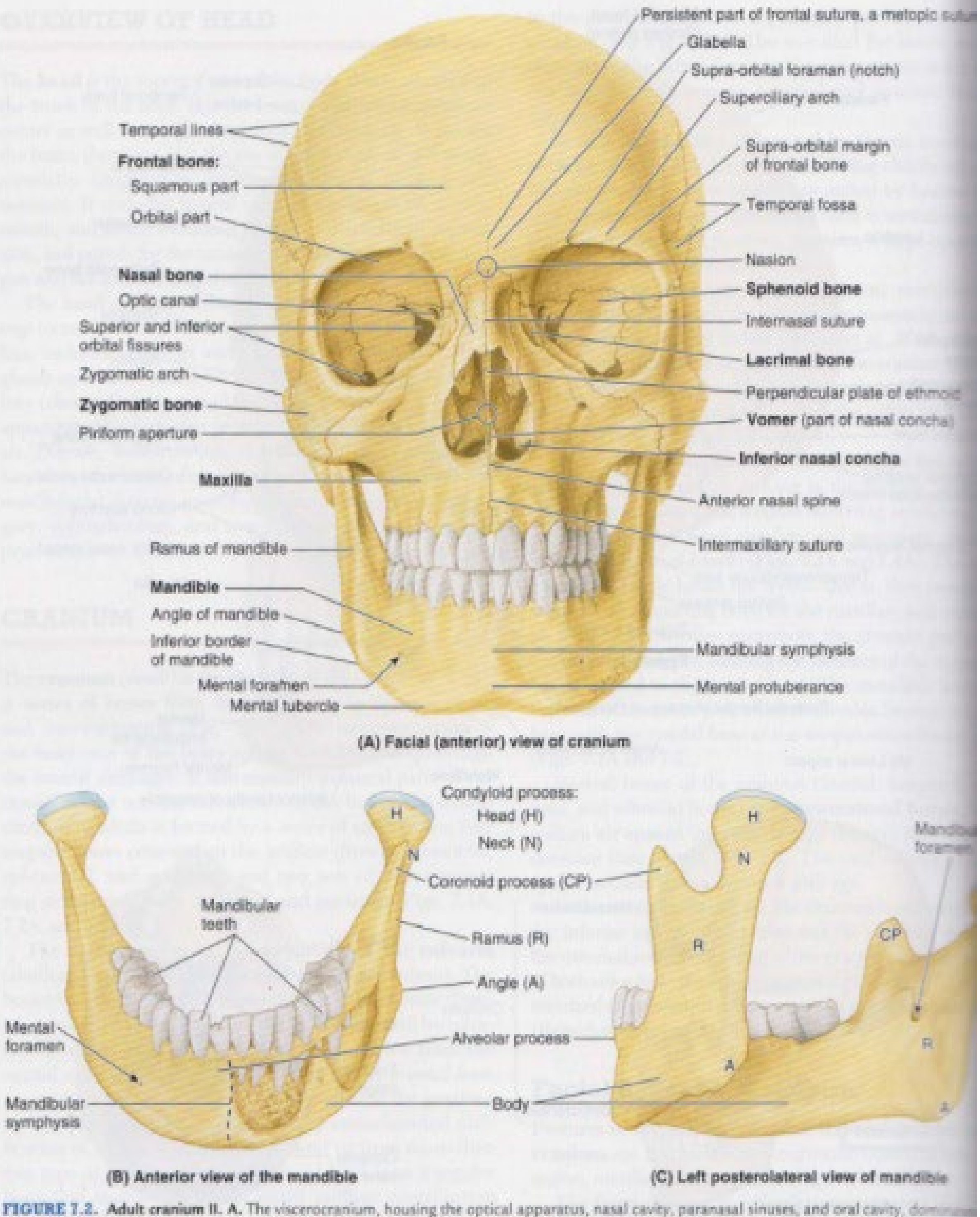


FIGURE 7.2. Adult cranium II. A. The viscerocranium, housing the optical apparatus, nasal cavity, paranasal sinuses, and oral cavity, domina facial aspect of the cranium. **B and C.** The mandible is a major component of the viscerocranium, articulating with the remainder of the cranium temporomandibular joint. The broad ramus and coronoid process of the mandible provide attachment for powerful muscles capable of genera force in relationship to biting and chewing (mastication).

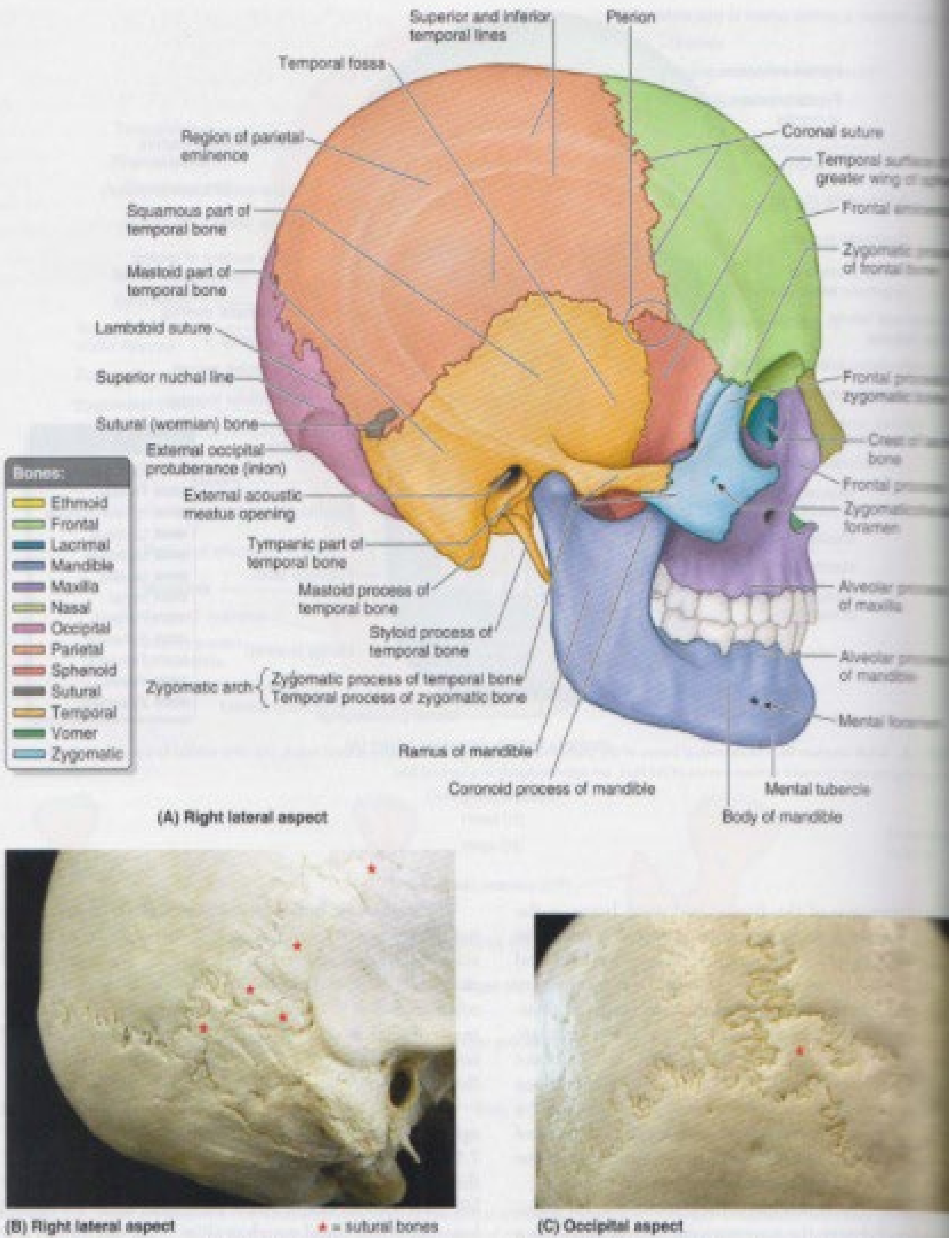
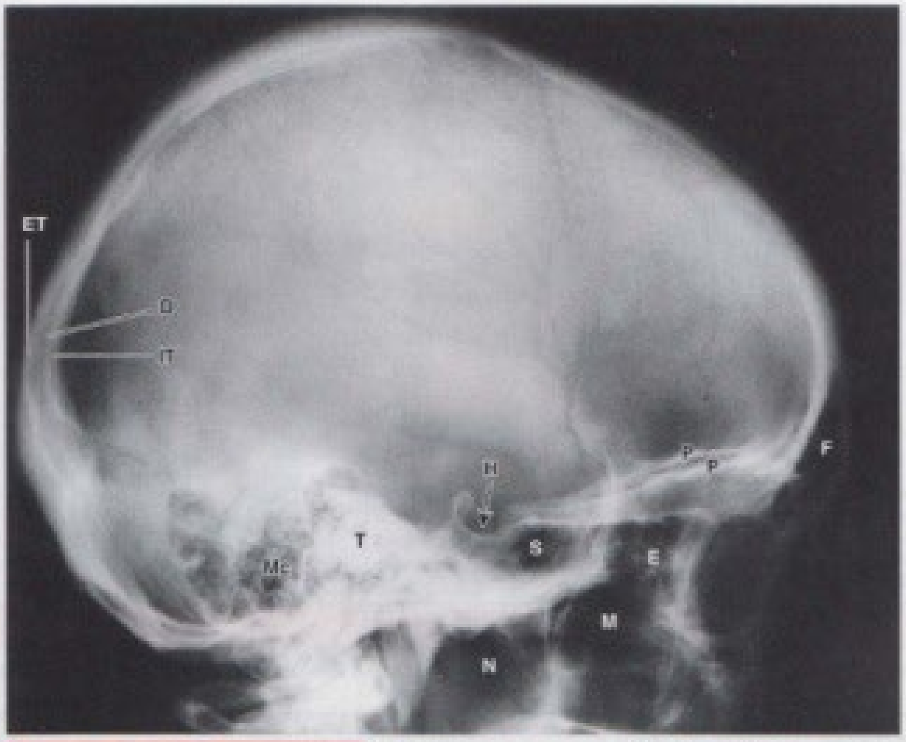
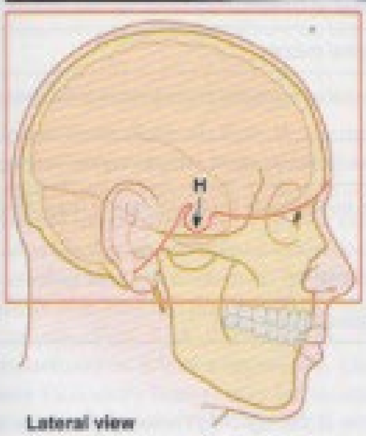


FIGURE 7.4. Adult cranium IV. A. The individual bones of the cranium are color coded. Within the temporal fossa, the pterion is a cranio the junction of the greater wing of the sphenoid, the squamous temporal bone, the frontal, and the parietal bones. **B and C.** Sutural bones the temporoparietal (**B**) and lambdoid (**C**) sutures are shown.





D	Diploë	Mc	Mastoid (air) cells
E	Ethmoid sinus	N	Nasopharynx
ET	External table of bone	P	Orbital part frontal bone
F	Frontal sinus	S	Sphenoidal sinus
H	Hypophysial fossa	T	Petrous part of temporal bone
IT	Internal table of bone		
M	Maxillary sinus		

FIGURE 7.5. Radiograph of cranium. Pneumatized (air-filled) bones contain sinuses or cells that appear as radiolucencies (dark areas) and bear the name of the occupied bone. The right and left orbital parts of the frontal bone are not superimposed; thus the floor of the anterior cranial fossa appears as two lines (*P*). (Courtesy of Dr. E. Becker, Associate Professor of Medical Imaging, University of Toronto, Toronto, Ontario, Canada.)

...nection with the zygomatic bones laterally and an ...bital **foramen** inferior to each orbit for passage of ...orbital nerve and vessels (Fig. 7.3).

...**andible** is a U-shaped bone with an alveolar pro-... supports the **mandibular teeth.** It consists of a ...al part, the **body,** and a vertical part, the **ramus** (...B & C). Inferior to the second premolar teeth are ...**tal foramina** for the mental nerves and vessels (...7.1A, 7.2A & B, and 7.3). The **mental protuber-**... ...ing the prominence of the chin, is a triangular ...tion inferior to the **mandibular symphysis** (... *menti*), the osseous union where the halves of ... mandible fuse (Fig. 7.2A & B).

Lateral Aspect of Cranium

The **lateral aspect of the cranium** is formed by both neurocranium and viscerocranium (Figs. 7.1A & B and 7.4A). The main features of the neurocranial part are the *temporal fossa*, the *external acoustic meatus opening*, and the *mastoid process of the temporal bone*. The main features of the viscerocranial part are the *infratemporal fossa*, *zygomatic arch*, and lateral aspects of the maxilla and mandible.

The **temporal fossa** is bounded superiorly and posteriorly by the **superior** and **inferior temporal lines,** anteriorly by the frontal and zygomatic bones, and inferiorly by the zygomatic arch (Figs. 7.1A and 7.4A). The superior border

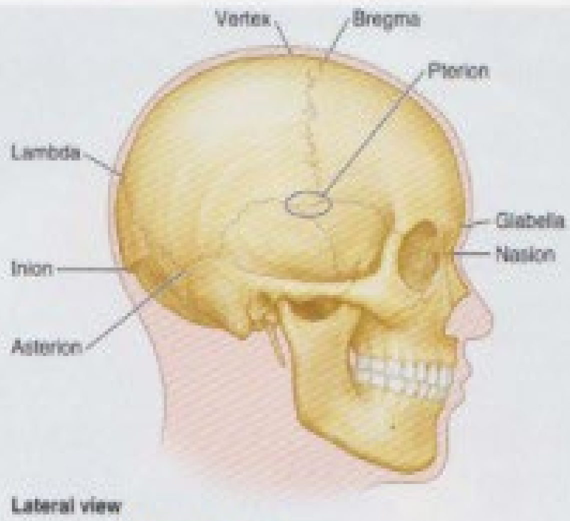


FIGURE 7.6. Craniometric points.

TABLE 7.1. CRANIOMETRIC POINTS OF CRANIUM

Landmark	Shape and Location
Pterion (G. wing)	Junction of greater wing of sphenoid, squamous temporal, frontal, and parietal bones; overlies course of anterior division of middle meningeal artery
Lambda (G. the letter *L*)	Point on calvaria at junction of lambdoid and sagittal sutures
Bregma (G. forepart of head)	Point on calvaria at junction of coronal and sagittal sutures
Vertex (L. whirl, whorl)	Superior point of neurocranium, in middle with cranium oriented in anatomical (orbitomeatal or Frankfort) plane
Asterion (G. asterios, starry)	Star shaped; located at junction of three sutures: parietomastoid, occipitomastoid, and lambdoid
Glabella (L. smooth, hairless)	Smooth prominence; most marked in males; on frontal bones superior to root of nose; most anterior projecting part of forehead
Inion (G. back of head)	Most prominent point of external occipital protuberance
Nasion (L. nose)	Point on cranium where frontonasal and internasal sutures meet

of this arch corresponds to the inferior limit of the cerebral hemisphere of the brain. The **zygomatic arch** is formed by the union of the **temporal process of the zygomatic bone** and the **zygomatic process of the temporal bone.**

In the anterior part of the temporal fossa, 3–4 cm superior to the midpoint of the zygomatic arch, is a clinically important area of bone junctions: the **pterion** (G. *pteron*, wing) (Figs. 7.4A and 7.6; Table 7.1). It is usually indicated by an H-shaped formation of sutures that unite the frontal, parietal, sphenoid (greater wing), and temporal bones. Less commonly, the frontal and temporal bones articulate; sometimes all four bones meet at a point.

The **external acoustic meatus opening** (**pore**) is the entrance to the *external acoustic meatus* (canal), which leads to the tympanic membrane (eardrum) (Fig. 7.4A). The **mastoid process** of the temporal bone is postero-inferior to the external acoustic meatus opening. Anteromedial to the mastoid process is the *styloid process of the temporal bone*, a needle-like, pointed projection. The *infratemporal fossa* is an irregular space inferior and deep to the zygomatic arch and the mandible and posterior to the maxilla (see Fig. 7.

Occipital Aspect of Cranium

The posterior or **occipital aspect of the cranium** is composed of the **occiput** (L. back of head, the convex posterior protuberance of the **squamous part of the occipital bone**), parts of the parietal bones, and mastoid parts of the temporal bones (Fig. 7.7A).

The **external occipital protuberance**, is usually palpable in the median plane; however, occasionally (especially in females) it may be inconspicuous. A craniometric point defined by the tip of the external protuberance is the **inion** (G. nape of neck) (Figs. 7.1A, 7.4A, and 7.6; Table

Appendix E Errors From Sample Scanned Pages

Source: Moore, K., L., Calley, A., F., Agur, A., M., R. 2014 (6th eds.) Clinically oriented anatomy. Wolters Kluwer.

OVERVIEW OF HEAD

The **head** is the superior part of the body that is attached tothe trunk by the neck. It is the control and communicationscenter as well as the "loading dock" for the body. It houses the brain ; therefore, it is the site of our consciousness: ideas, creativity, imagination , responses , decision making, and

,, memory. It includes special sensory receivers (eyes, ears,

mouth, and nose), broadcast devices for voice and expres-

sion, and portals for the intake of fuel (food), water, and oxy- gen and the exhaust of carbon dioxide.

The head consists of the *brain* and its protective cover- ings (cranial vault and meninges), the *ears,* and the*fac e*. The face includes openings and passageways , with lubricating glands and valves (seals) to close some of them , the mastica- tory (chewing) devices, and the orbits that house the visual apparatus. The face also provides our identity as individu-als. Disease, malformation, or trauma of structures in thehead form the bases of many specialties, including dentistiy, maxillofacial surgery, neurology, neuroradiology , neurosur-gery, ophthalmology, oral surgery, otology, rhinology, and psychiatiy.

CRANIUM

The **cranium** (skull[1]) is the skeletpn of the head (Fig. 7.1A). A series of bones form its two parts , the neurocranium and viscerocranium (Fig. 7.lB). The **neurocranium** is the bony case of the brain and its membranous cove lings, the cranial meninges. It also contains proximal parts of the cranial nerves and the vasculature of the brain. The neuro- cranium ı11 adults is formed by a series of eight bones: four singular bones centered on the midline *lfrontal, ethmoidal, sphenoidal,* and *occipital),* and two sets of bones occur- ring as bilateral pairs *(temporal* and *pari etal)* (Figs. 7.lA, 7.2A, and 7.3).

The *neurocranium* has a dome-like roof, the **calvaria** (skullcap), and a floor or **cranial base** (basicranium). Thebon es forming the *calvaria* are primarily fl.at bones (fron- tal , parietal , and occipital; see Fig. 7.8A) formed by intra-membranous ossification of head mesenchyrne from the neural crest. The bones contributing to the *cranial base*are primarily irregular bones with substantial flat portions(sphenoidal and te

mporal) formed by endochondral ossi-fication of cartilage *(chondrocranium)* or from more thanone type of ossification . The *ethmoid bone* is an irregularbone that makes a relatively minor midline contribution

'There is confusion about exactly what the term *skull* means. It may mean the cranium (which includes tl1 e mandible), or tl1 e part of tl1 e cranium excluding tl1 e mandibl e. There has also been confusion because some people have used tlie term *cranium* for only tl1 e neurocranium. The Federative International Committee on Anatomical Terminology (FICAT) has decided to follow the Latin term *cranium* for the skeleton of the head.

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bones (sphenoid and occipital) are united b

!age (**synchondroses**). The spinal cord is c" the brain through the *foramen magnum,* a la-_ the cranial base (Fig. 7.1C).

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!ates with the cranial base at the *ternporoma* (Figs. 7.1A and 7.2). Temporal fossa (dashed outline)

Several bones of the cranium (frontal, te noid, and ethmoid bones) are **pneumatized** contain **air spaces** *(air cells* or large *sinuses* . • decrease their weight (Fig. 7.5). The total ,·olspaces in these bones increases with age.

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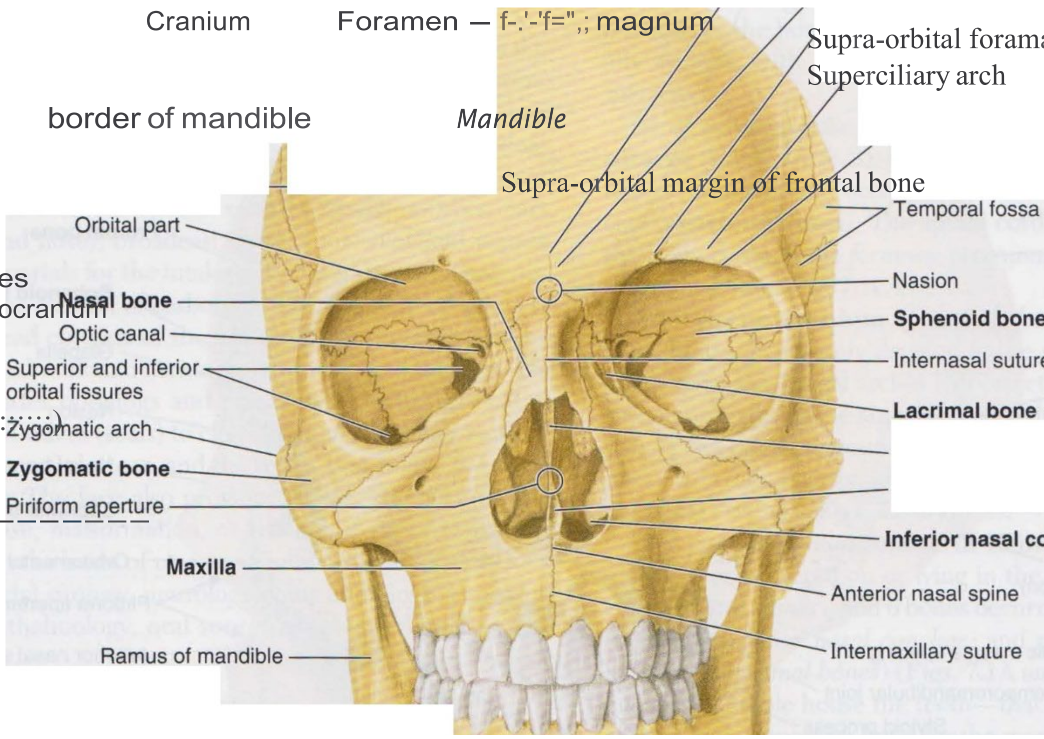
Facial Aspect of Cranium

Features of the anterior or **facial (frontal) ascranium** are the frontal and zygomatic bone region, maxillae, and mandible (Figs. 7.2 and - '

The **frontal bone,** specifically its **squamo** forms the skeleton of the forehead, articulati _ with the nasal and zygomatic bones. In some ad *suture* persists; this rem nant is called a **metopi**

in the middle of the **glabella,** the smooth, slivh area between the superciliary arches. The **fro** divides the frontal bones of the fetal cranium box "Development of Cranium," p. 839).



Adult cranium I. A. In the anatomical position, the inferior margin of the orbit and the superior margin of the external acoustic meatus lie in

horizontal orbitomeatal (Frankfort horizontal) plane. **B.** The neurocranium and viscerocranium are the two primary functional parts of the cranium.

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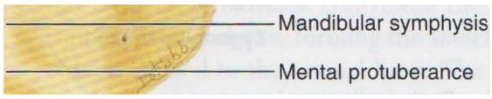
o sphenoid and occipital bones make substantial contributions to the cranial base. The spinal cord is continuous with the brain through the foramen

the large opening in the basal part of the occipital bone.

Mandible

Angle of mandible -------- Inferior border — — — — —

of mandible ---- ,;r'



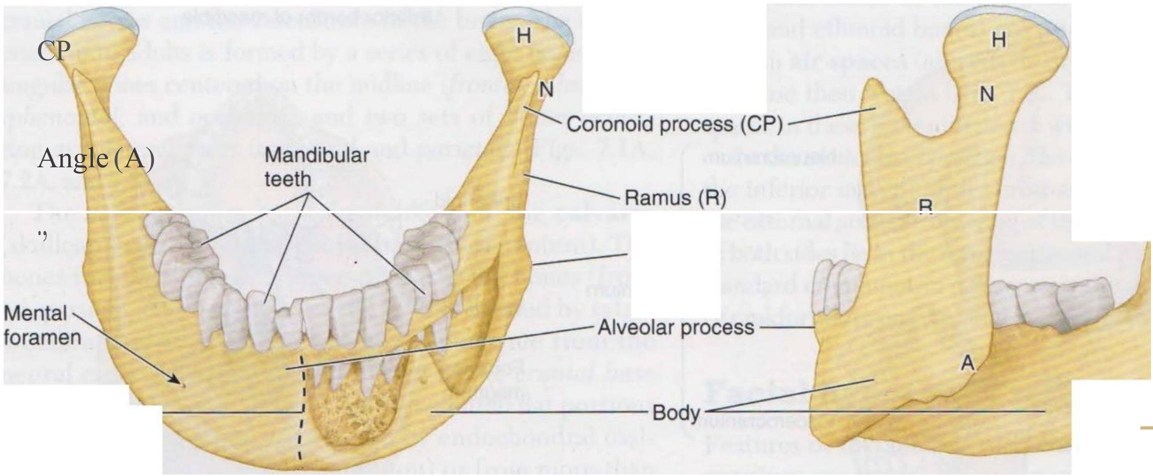
Mental forafnen /

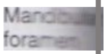
Mental tubercle — — — —

Facial (anterior) view of cranium

Condyloid process: Head (H)

Neck (N)

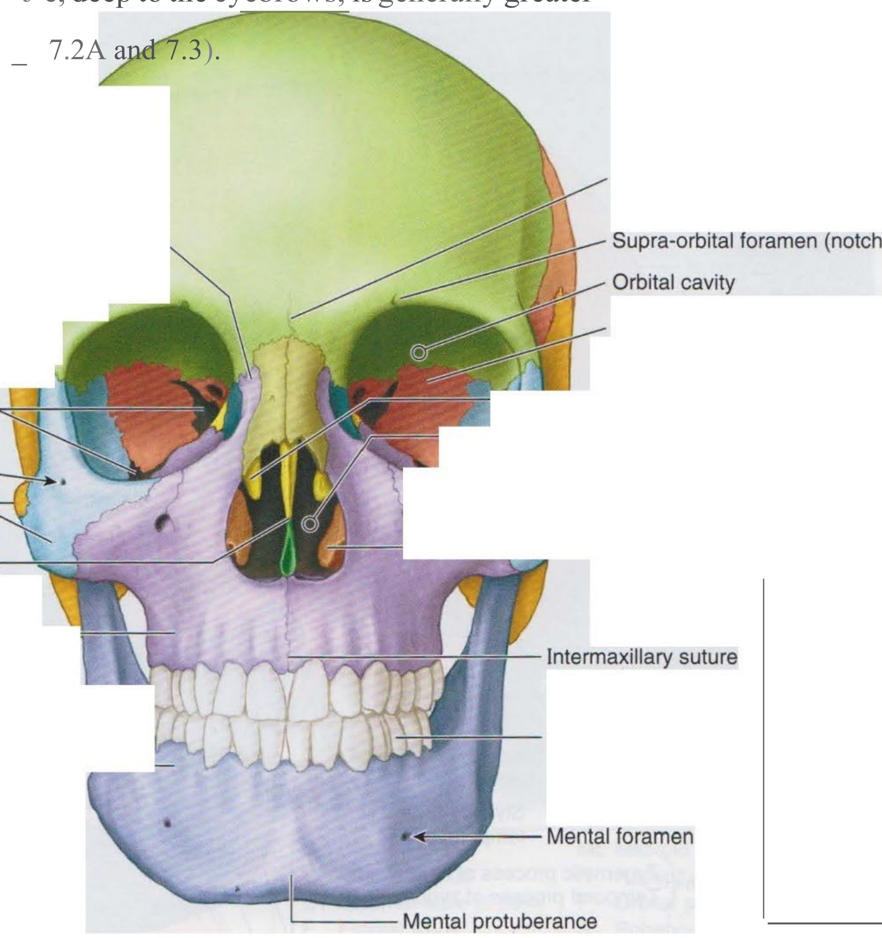




1argin is a ridge, the superciliary arch, that v on each side from the glabella. The promi-

-J e, deep to the eyebrows, is generally greater

7.2A and 7.3).



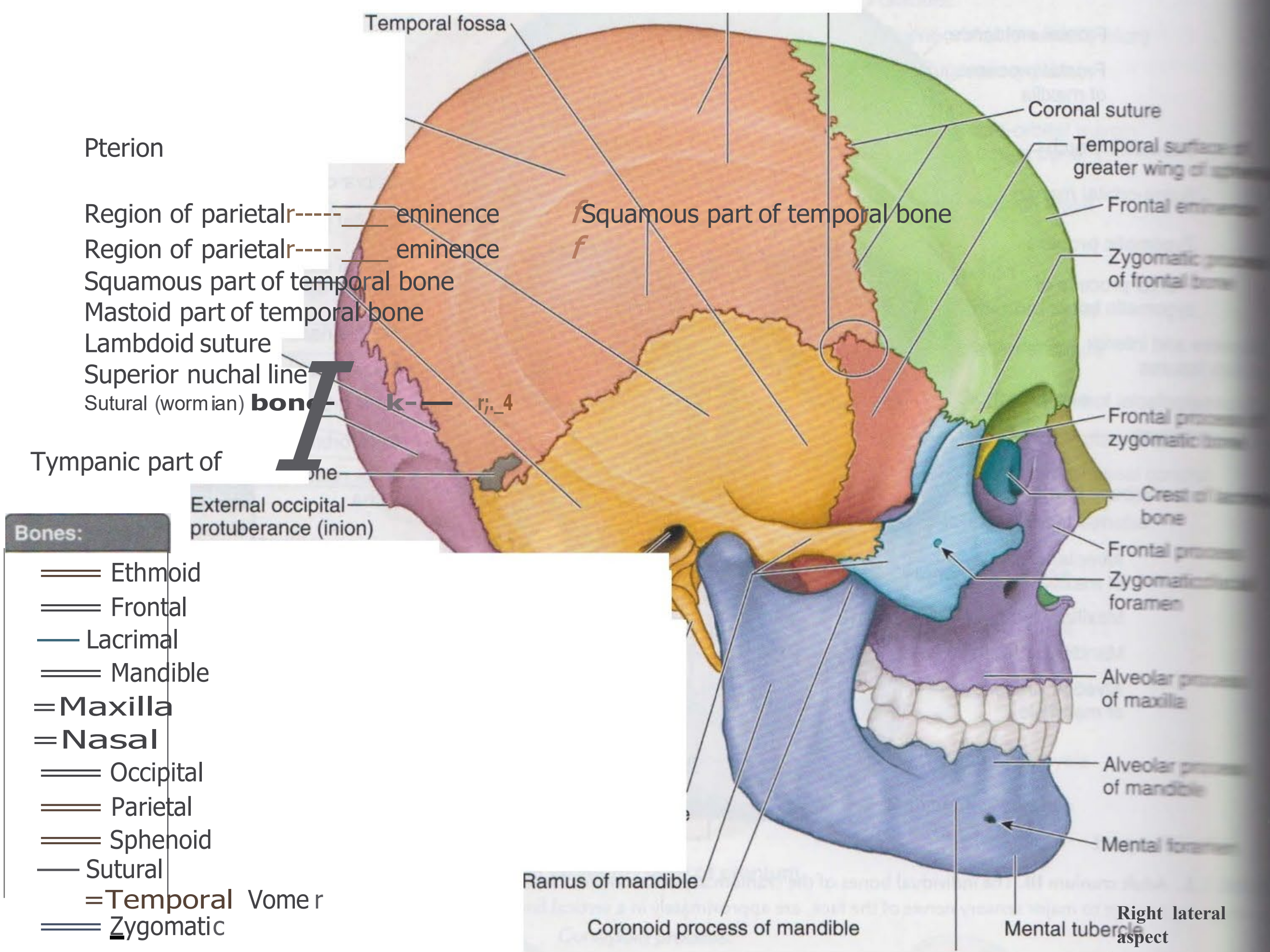
·tion of the frontal and nasal bones is the *11s,* nose), which in most people is related topressed area (bridge of nose) (Figs. 7.lA andon is one of many *craniometric points* that ar_e hically in medicine (or on dry crania in physi-

·:y) to make cranial measurements, compare '.e topography of the cranium, and documenttions (Fig. 7.6; Table 7.1). The frontal bonewith the lacrimal, ethmoid, and sphenoids; a

·on of bone (*orbital part*) forms both the roof J part of the floor of the anterior part of theFig. 7.3).

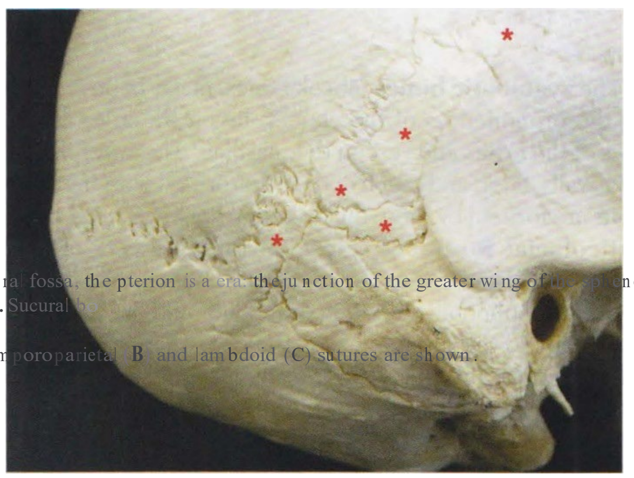
-orbital margin of the frontal bone, the angu- tween the squamous and orbital parts, has a foramen (notch) in some crania for passage rbital nerve and vessels. Just superior to the

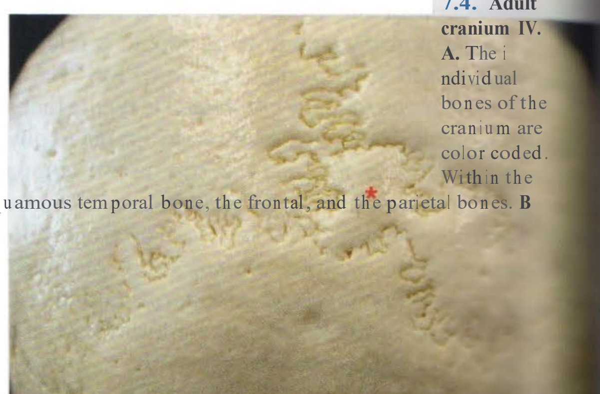
Right lateral aspect Body of mandible



Right lateral aspect

* = sutural bones





(C) Occipital aspect

FIGURE 7.4. Adult cranium IV. A. The individual bones of the cranium are color coded. Within the temporal fossa, the pterion is a cra... the junction of the greater wing of the sphenoid, the squamous temporal bone, the frontal, and the parietal bones. **B and C.** Sucural bo... the temporoparietal (B) and lambdoid (C) sutures are shown.

appears two lines (P). (Courtesy of Dr. E. Becker, Associate Professor of Medical Imaging, University of Toronto, Toronto, Ontario, Canada.).

Lateral Aspect of Cranium

The lateral aspect of the cranium is formed by both neu- rocranium and viscerocranium (Figs. 7.1A & B and 7.4A). The main features of the neurocranial pa1t are the *temporal fossa,* the *external acoustic meatus opening,* and the *mas- toid process of the temporal bone.* The main features of the viscerocranial part are the *infratemporal fossa, zygomatic arch,* and lateral aspects of the maxilla and mandible.

The temporal fossa is bounded superiorly and posteri- orly by the superior and inferior temporal lines, anteri- orly by the frontal and zygomatic bones, and inferiorly by the zygomatic arch (Figs. 7.1A and 7.4A). The supe1ior border

Lateral view

·on with the zygomatic bones laterally and an foramen inferior to each orbit for passage of

·al nerve and vessels (Fig. 7.3).

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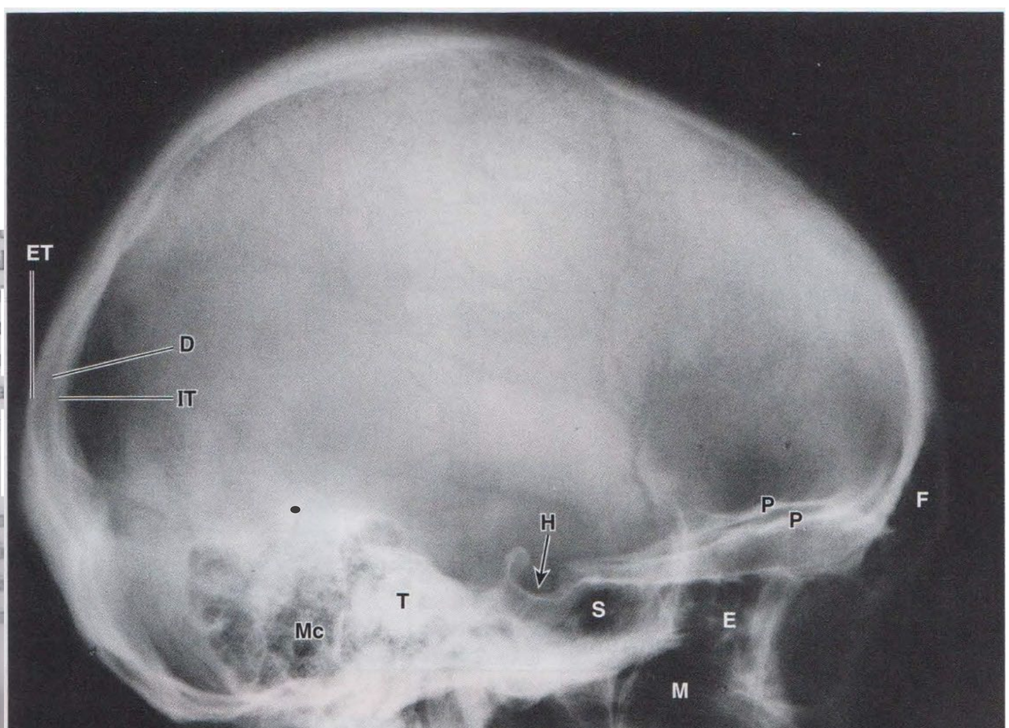
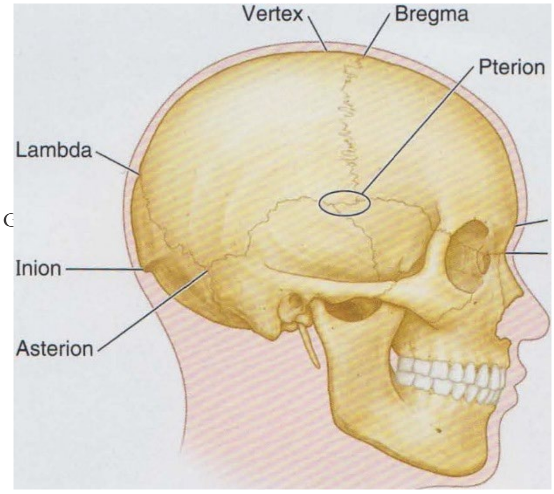
:xirts the mandibular teeth. It consists of a

. the body, and a vertical part, the ramus

- C). Inferior to the second premolar teeth are foramina for the mental nerves and vessels

Lateral view





nGURE 7 .6. **Craniometric points.**

TABLE 7 .1. CRANIOMETRIC POINTS OF CRANIUM

Landmark	**Shape and Location**
Pterion (G. wing)	Junction of greater wing of sphenoid, squamous temporal, frontal, and parietal bones; overi ;;-;:anterior division of middle meningeal artery
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Bregma (G. forepart of head)	Point on calvaria at junction of coronal and sagittal sutures
Vertex (L. whirl, whorl)	Superior point of neurocranium, in middle with cranium oriented in anatomical (orbitomeata
Asterion (G. *asterios,* starry)	Star shaped; located at junction of three sutures: parietomastoid, occipitomastoid, and lam

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Inion (G. back of head}	Most prominent point of external occipital protuberance
Nasion (L. nose)	Point on cranium where frontonasal and internasal sutures meet

of this arch corresponds to the inferior limit of the cerebral hemisphere of the brain . The **zygomatic arch** is formed by the union of the **temporal process of the zygomatic bone** and the **zygomatic process of the temporal bone.**

In the anterior part of the temporal fossa, 3--4 cm superior to the midpoint of the zygomatic arch, is a clinically impor- tant area of bone junctions: the **pterion** (G. *pteron ,* wing) (Figs . 7.4A and 7.6; Table 7.1). It is usually indicated by an H-shaped formation of sutures that unite the frontal, pari- etal, sphenoid (greaterwing), and temporal bones. Less com- monly, the frontal and temporal bones articulate; sometimes all four bones meet at a point.

The **external acoustic meatus opening (pore)** is the entrance to the *external acoustic meatus* (canal), which leads to the tympanic membrane (eardrum) (Fig. 7.4A). The **mastoid process** of the temporal bone process is the *styloid process of the tempora*needle-like, pointed projection. The *infrate* irregular space inferior and deep to the zy!!! the mandible and posterior to the maxilla (ee

Occipital Aspect of Cranium

The posterior or **occipital aspect of the** cposed of the **occiput** (L. back of head, **th** rior protuberance of the **squamous part o bone),** parts of the parietal bones, and mas temporal bones (Fig. 7.7A).

Appendix F Sample from Scalpel

BM COURSE YEAR 1

Foundations of Medicine

COMPUTER PRACTICAL 1

CELL INJURY AND ADAPTATION

Aims:

Following this practical you should:

1. Understand the principles of hypertrophy, hyperplasia, atrophy and metaplasia in response to physiological and pathological stimuli.

2. Be able to describe the mechanisms responsible for these processes in a clinical context.

HYPERTROPHY AND HYPERPLASIA

Increase in size and functional capacity of a tissue or organ may occur in response to increased demand. This is brought about by an increase in the size of individual cells **(hypertrophy)** or by an increase in the number of cells present **(hyperplasia)**. Both may be either physiological or pathological. Sometimes a combination of both processes occurs.

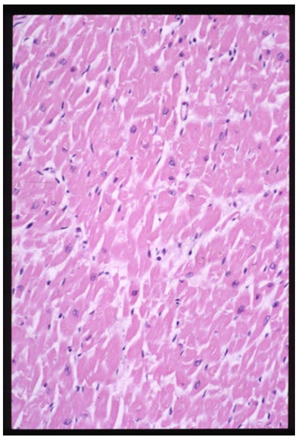
Left Ventricular Hypertrophy. Photographs A, B.

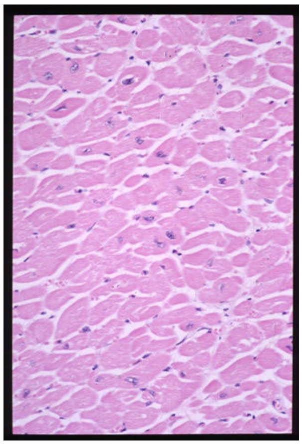
Photograph A shows an essentially normal heart and photograph B represents a massively hypertrophied heart from a patient with high blood pressure (hypertension).

Questions:

	True	False
1. The left ventricle has thicker myocardium than the right	◯	◯
2. Left ventricular enlargement in patients with high blood pressure involves muscle cell proliferation	◯	◯
3. Myocardial hypertrophy initially increases cardiac output	◯	◯
4. Myocardial ischaemia is a limiting factor for hypertrophy	◯	◯
5. Right ventricular hypertrophy does not occur	◯	◯

Photograph C (i and ii) shows the microscopic appearances of normal and hypertrophied left ventricular myocardium, each photographed at identical magnification.





Questions:

	True	False
6. Photograph C (i) represents normal myocardium	◯	◯
7. Photograph C (ii) represents hyperplastic myocardium	◯	◯
8. In hypertrophy, cell enlargement is due to increase in functional components	◯	◯
9. Aortic valve stenosis can cause left ventricular hypertrophy	◯	◯
10. Narrowing of the coronary arteries, e.g. due to coronary artery atherosclerosis, causes left ventricular hypertrophy	◯	◯

Hyperplasia

Prostatic Hyperplasia. Photograph D (i)

This is a picture of the bladder from a man aged 75 years. The nodular mass of tissue at the bladder neck is the prostate gland, responsible for producing some of the components of seminal fluid. Normally smaller than a golf ball, the prostate gland in older men often becomes hyperplastic in response to alterations in the balance of testosterone and oestrogen hormones in the body. A photograph of a normal bladder - **Photograph D (ii)** - is also available, for comparison.

Questions:

	True	False
11. Confirmation that the enlargement of this prostate gland is due to hyperplasia rather than hypertrophy requires histological examination	○	○
12. Prostatic hyperplasia is due to relatively increased testosterone levels	○	○
13. The main clinical effects reflect difficulty in passing urine	○	○
14. Prostatic hyperplasia is potentially reversible	○	○
15. Prostatic glandular epithelium is a labile tissue	○	○

ATROPHY

This term is applied to the reduction in size of an organ or tissue, *either* due to shrinkage in cell size, *or* to loss of cells. It may be physiological (e.g., atrophy of the uterus after the menopause) or pathological (e.g., disuse atrophy of muscles when a limb is immobilised in plaster during the healing of a fracture).

Post-menopausal atrophy of the uterus. Photograph E.

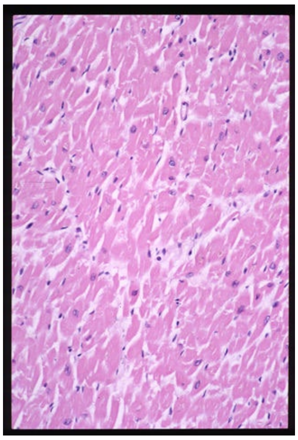
This photograph shows vertical slices through the uterus of a young woman and that of an elderly, post-menopausal woman.

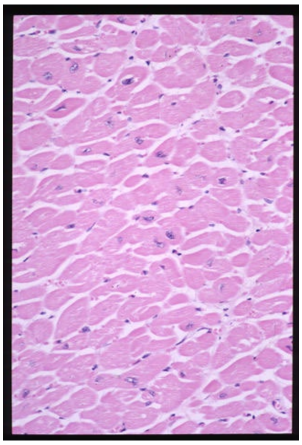
Questions:

	True	False
16. The larger uterus is that from the younger woman	◯	◯
17. The difference in size is mainly due to post-menopausal reduction in the bulk of smooth muscle in the wall of the organ	◯	◯
18. Endometrial atrophy also occurs after the menopause	◯	◯
19. Enlargement of the uterus in pregnancy is mainly due to hyperplasia	◯	◯
20. Increased progesterone production after the menopause accounts for atrophy of the uterus	◯	◯

METAPLASIA

This refers to the replacement of one mature, specialised cell type by a different specialised cell type. Metaplasia is an adaptive response to a persistently adverse environment. Examples include squamous metaplasia of the bronchial epithelium in cigarette smokers and gastric/intestinal metaplasia of the distal oesophagus ("Barrett's oesophagus") in response to chronic reflux of acid and peptic enzymes from the stomach.





Squamous Metaplasia in the Bronchus. Photograph F.

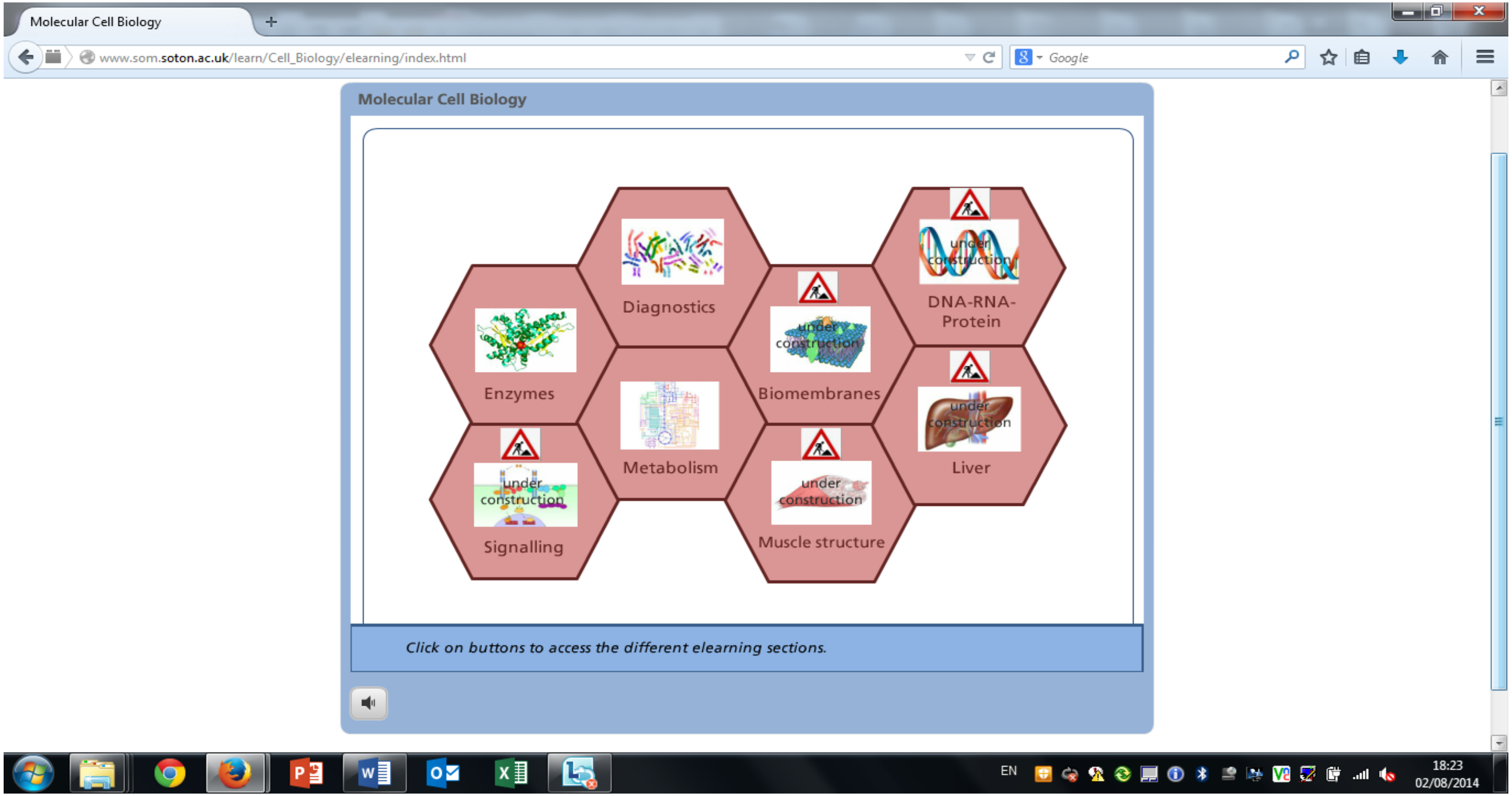
Questions:

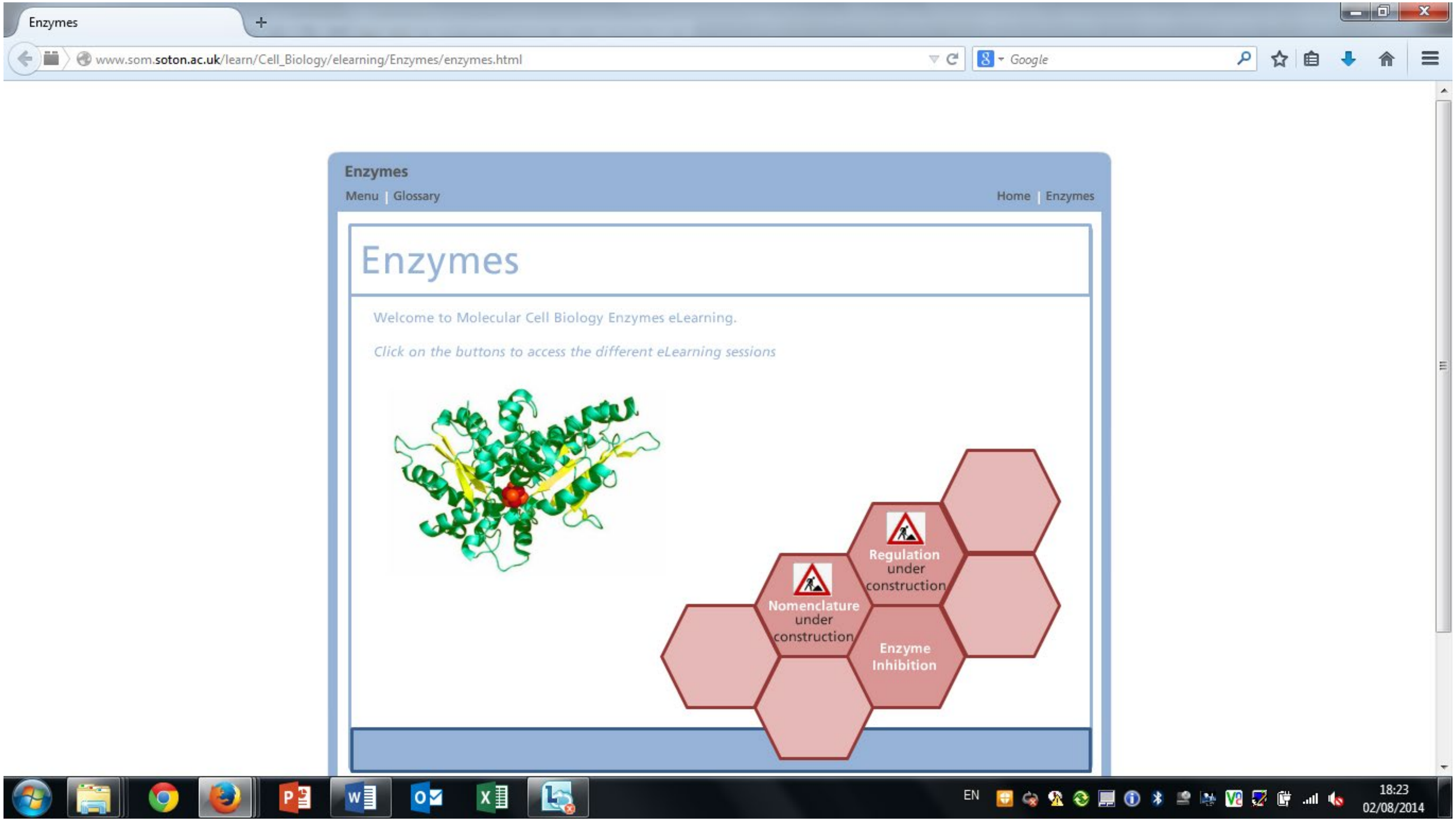
	True	False
21. The normal bronchus is lined by stratified columnar epithelium	○	○
22. Columnar epithelium is resistant to toxic effects of cigarette smoke	○	○
23. Squamous epithelium is resistant to toxic effects of cigarette smoke	○	○
24. Metaplasia in the bronchial epithelium occurs via mature goblet cells changing into squamous cells.	○	○
25. Squamous metaplasia is entirely beneficial in the airways of smokers.	○	○

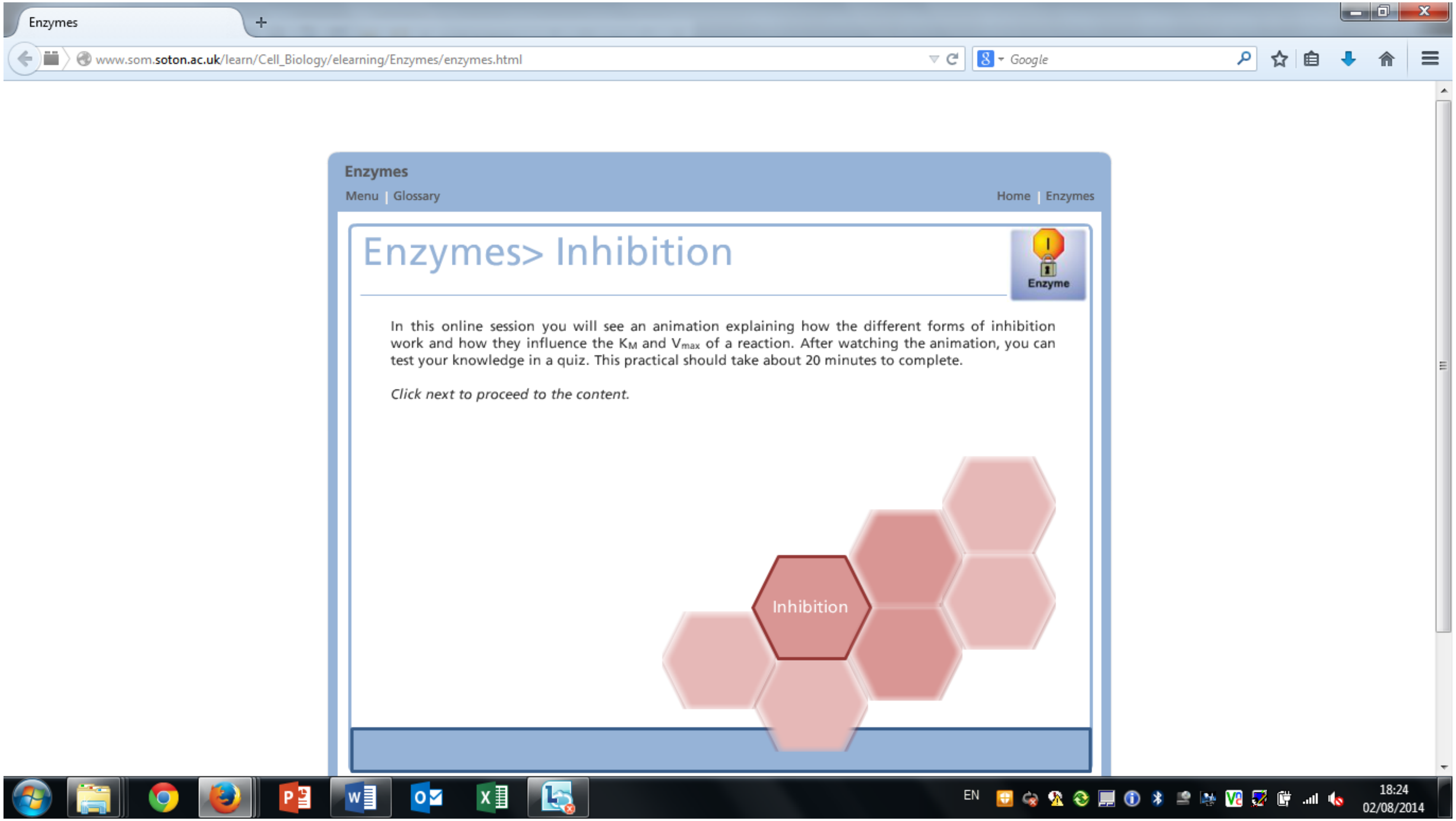
Score =

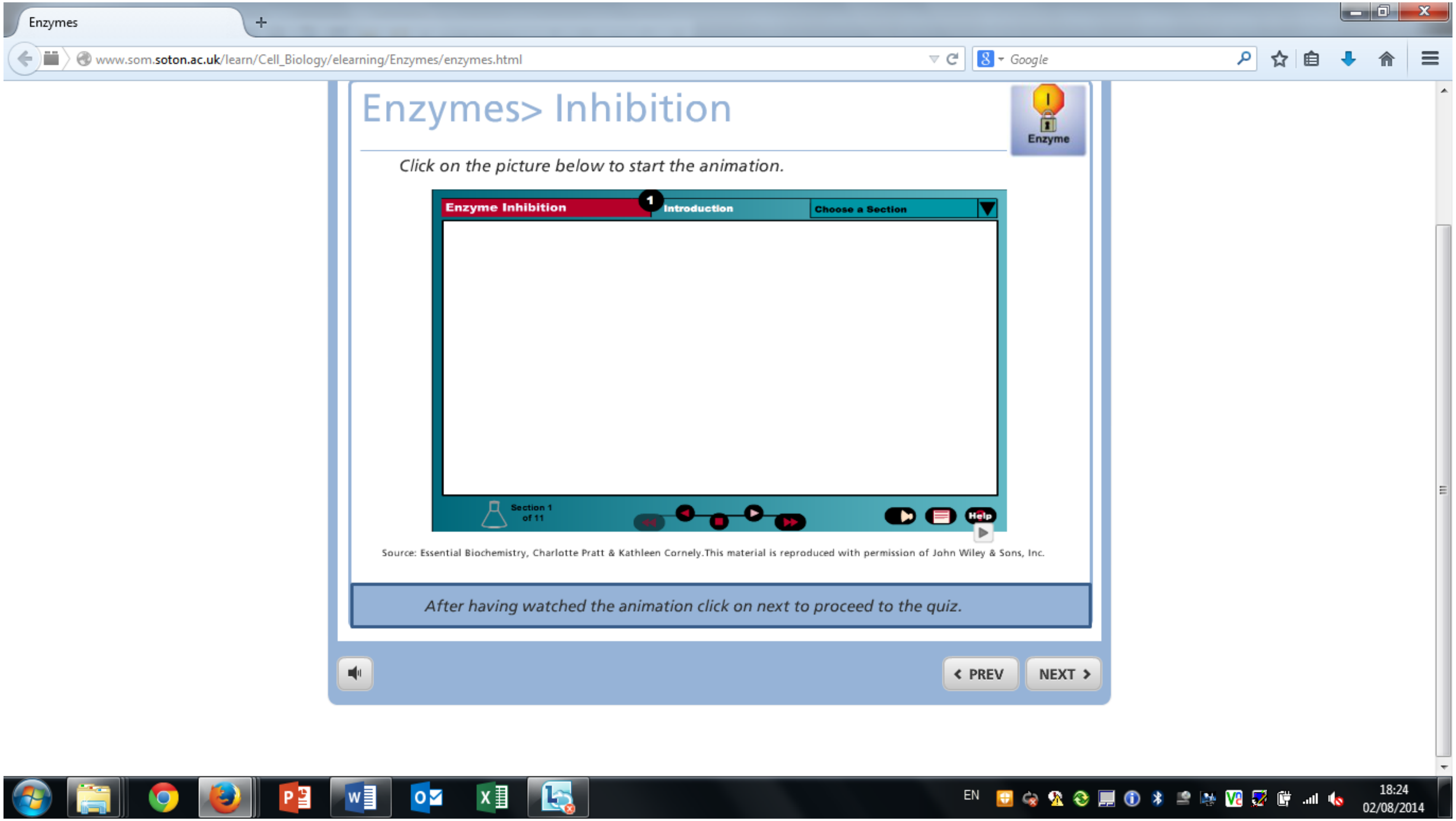
Comments/Incorrect Answers:

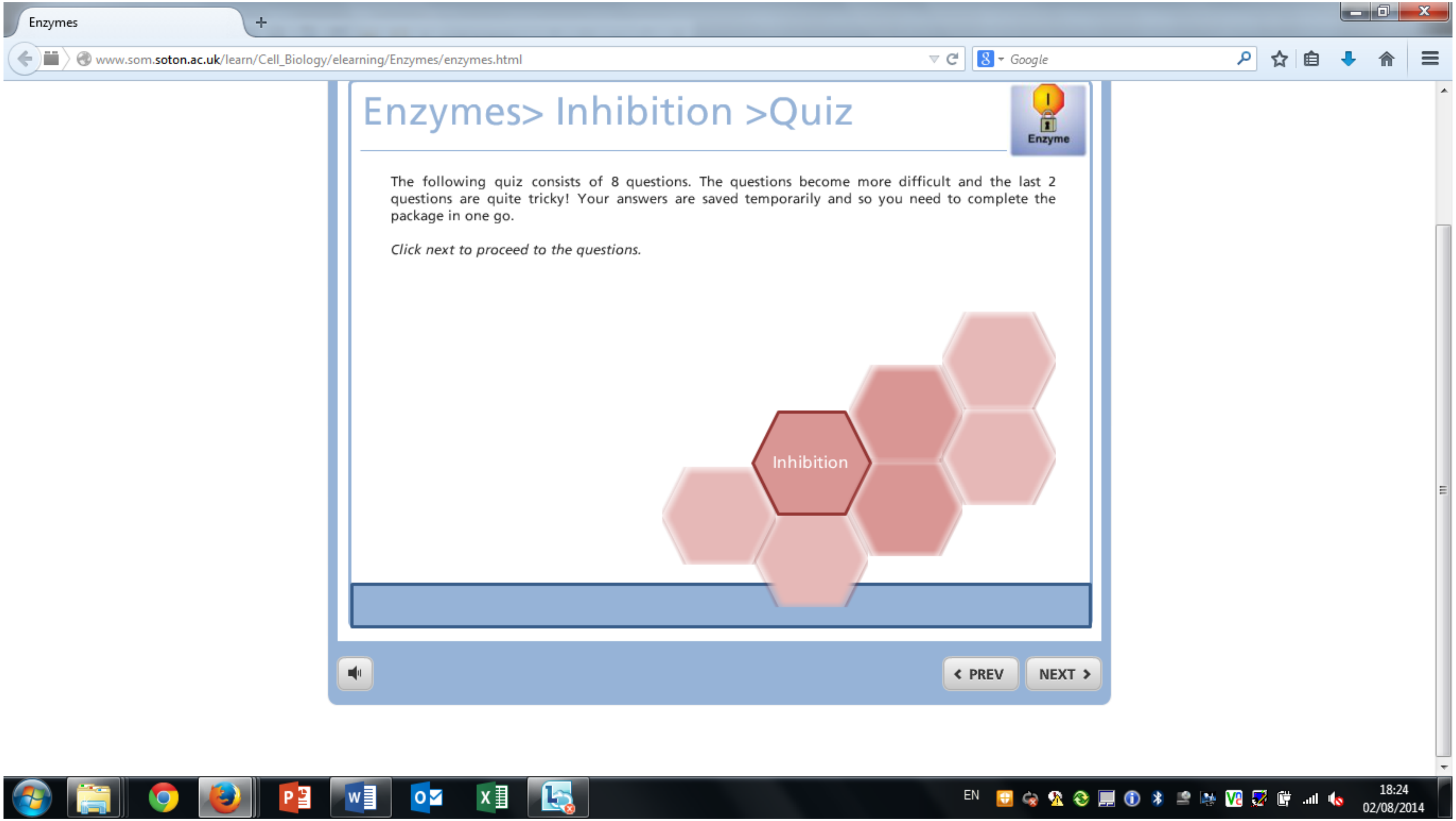
Appendix G Sample of a Pathology Interactive Practical (PiP) Resource




Enzymes
www.som.soton.ac.uk/learn/Cell_Biology/elearning/Enzymes/enzymes.html
Google
Enzymes
Menu | Glossary
Home | Enzymes
Enzymes
Welcome to Molecular Cell Biology Enzymes eLearning.
Click on the buttons to access the different eLearning sessions
Regulation under construction
Nomenclature under construction
Enzyme Inhibition
EN
18:23
02/08/2014


Enzymes
www.som.soton.ac.uk/learn/Cell_Biology/elearning/Enzymes/enzymes.html
Google
Enzymes
Menu | Glossary
Home | Enzymes
Enzymes> Inhibition
Enzyme
In this online session you will see an animation explaining how the different forms of inhibition work and how they influence the K_M and V_{max} of a reaction. After watching the animation, you can test your knowledge in a quiz. This practical should take about 20 minutes to complete.
Click next to proceed to the content.
Inhibition
EN
18:24
02/08/2014


Enzymes
www.som.soton.ac.uk/learn/Cell_Biology/elearning/Enzymes/enzymes.html
Google
Enzymes> Inhibition
Enzyme
Click on the picture below to start the animation.
Enzyme Inhibition
Introduction
Choose a Section
Section 1 of 11
Help
Source: Essential Biochemistry, Charlotte Pratt & Kathleen Cornely.This material is reproduced with permission of John Wiley & Sons, Inc.
After having watched the animation click on next to proceed to the quiz.
PREV
NEXT
EN
18:24
02/08/2014


Enzymes
www.som.soton.ac.uk/learn/Cell_Biology/elearning/Enzymes/enzymes.html
Google
Enzymes> Inhibition >Quiz
Enzyme
The following quiz consists of 8 questions. The questions become more difficult and the last 2 questions are quite tricky! Your answers are saved temporarily and so you need to complete the package in one go.
Click next to proceed to the questions.
Inhibition
PREV
NEXT
EN
18:24
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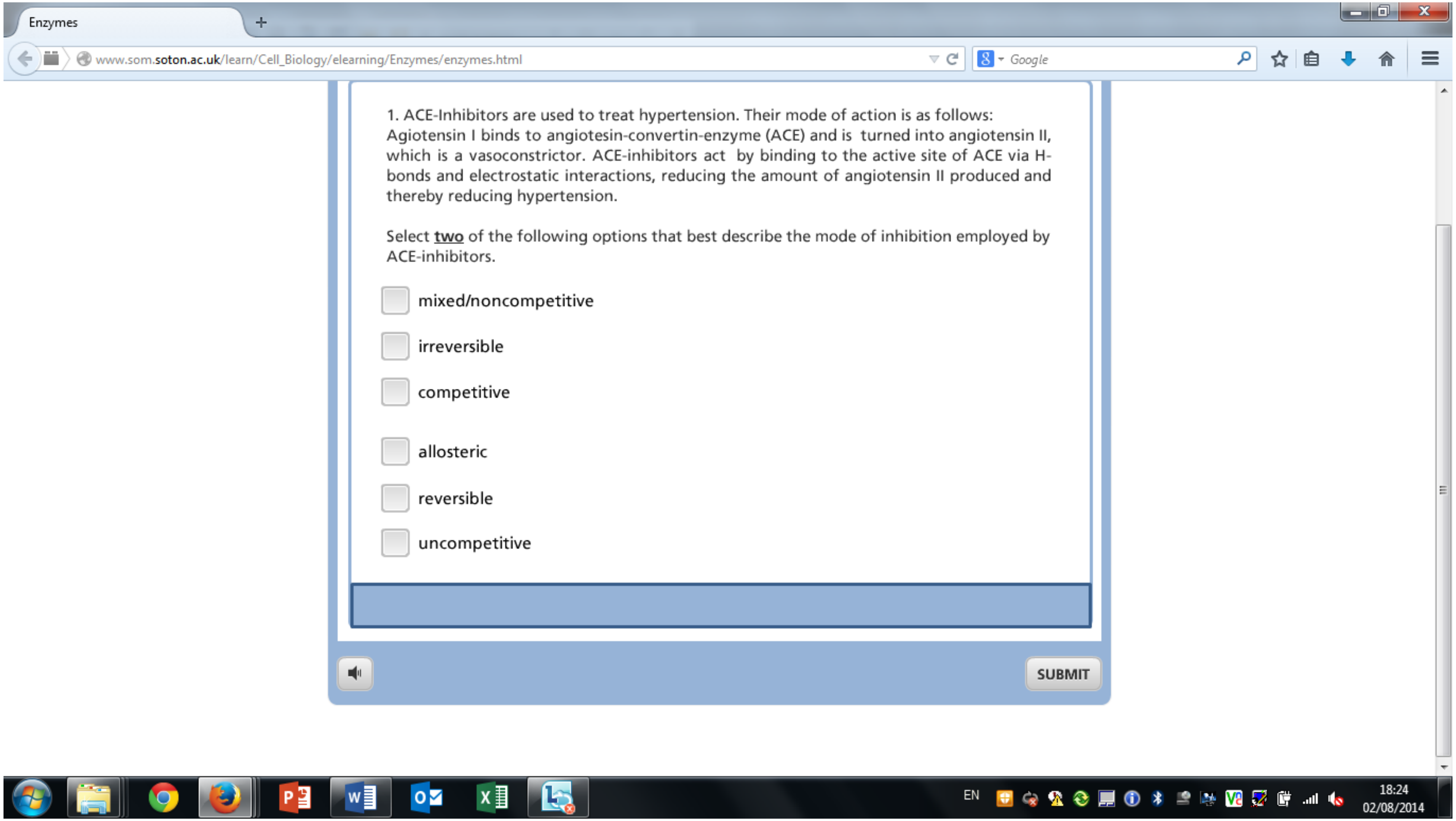
Enzymes
www.som.soton.ac.uk/learn/Cell_Biology/elearning/Enzymes/enzymes.html
Google
1. ACE-Inhibitors are used to treat hypertension. Their mode of action is as follows: Agiotensin I binds to angiotesin-convertin-enzyme (ACE) and is turned into angiotensin II, which is a vasoconstrictor. ACE-inhibitors act by binding to the active site of ACE via H-bonds and electrostatic interactions, reducing the amount of angiotensin II produced and thereby reducing hypertension.
Select two of the following options that best describe the mode of inhibition employed by ACE-inhibitors.
mixed/noncompetitive
irreversible
competitive
allosteric
reversible
uncompetitive
SUBMIT
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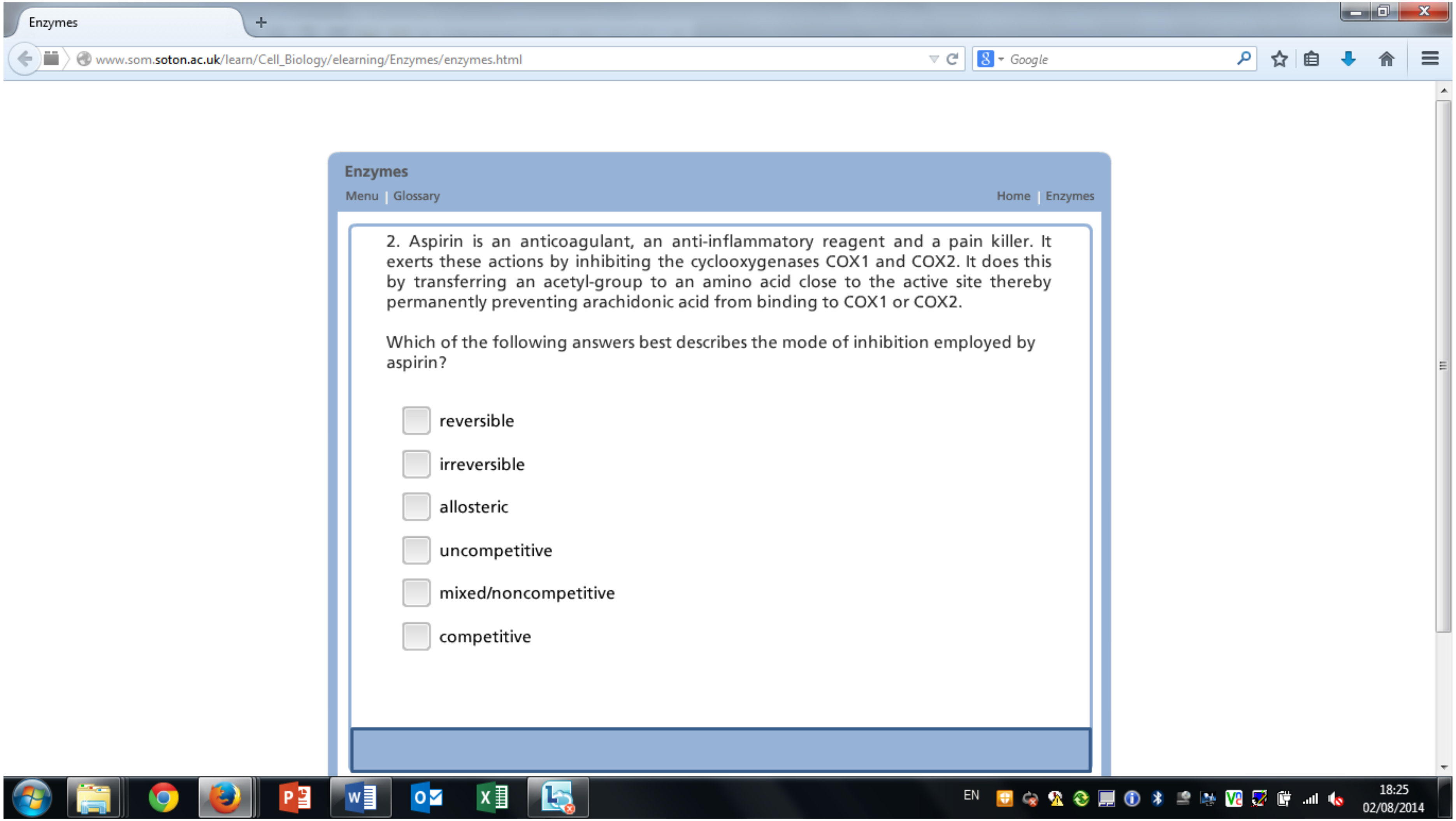
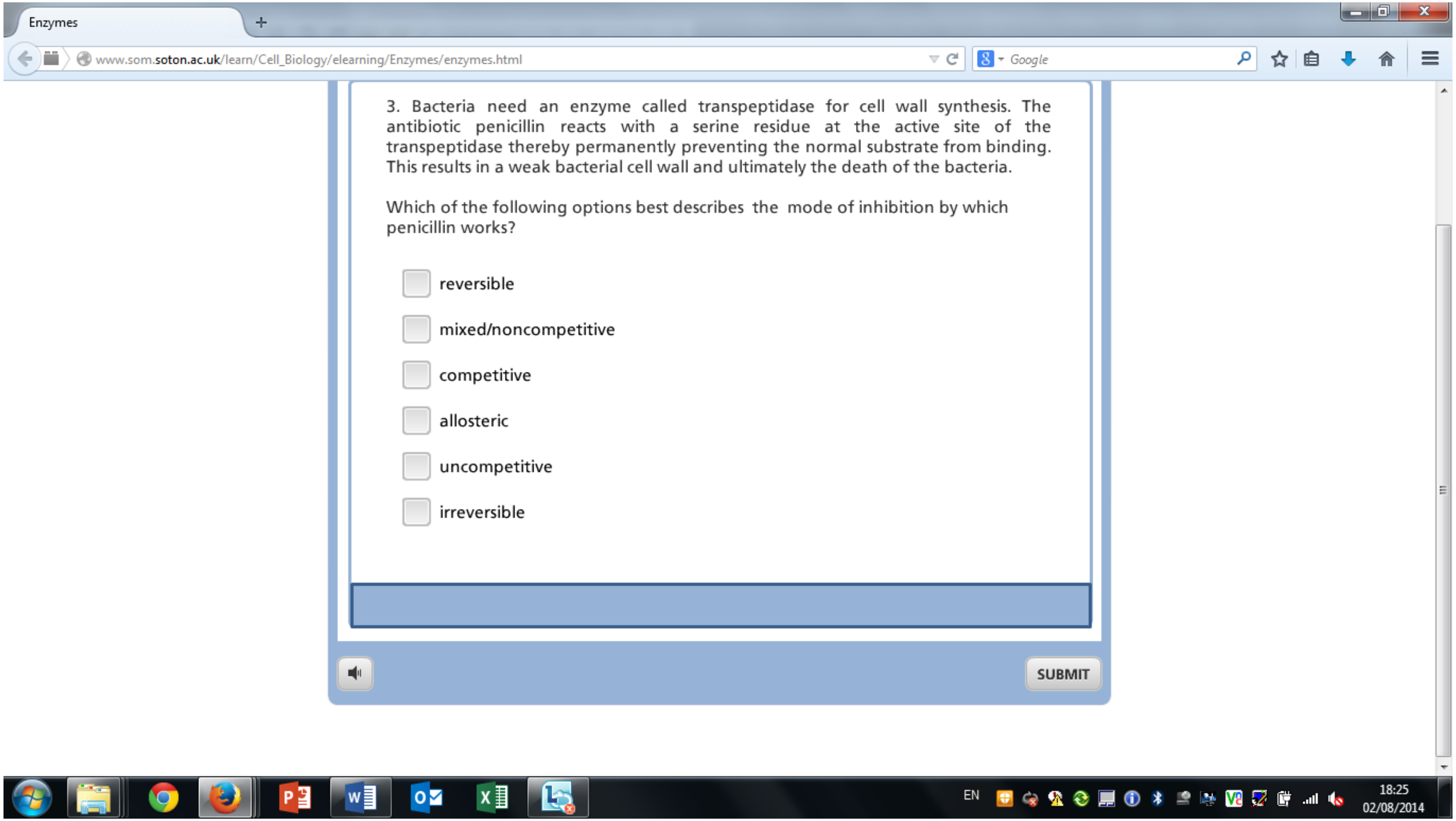
02/08/2014


Enzymes
www.som.soton.ac.uk/learn/Cell_Biology/elearning/Enzymes/enzymes.html
Google
Enzymes
Menu | Glossary
Home | Enzymes
2. Aspirin is an anticoagulant, an anti-inflammatory reagent and a pain killer. It exerts these actions by inhibiting the cyclooxygenases COX1 and COX2. It does this by transferring an acetyl-group to an amino acid close to the active site thereby permanently preventing arachidonic acid from binding to COX1 or COX2.
Which of the following answers best describes the mode of inhibition employed by aspirin?
reversible
irreversible
allosteric
uncompetitive
mixed/noncompetitive
competitive
EN
18:25
02/08/2014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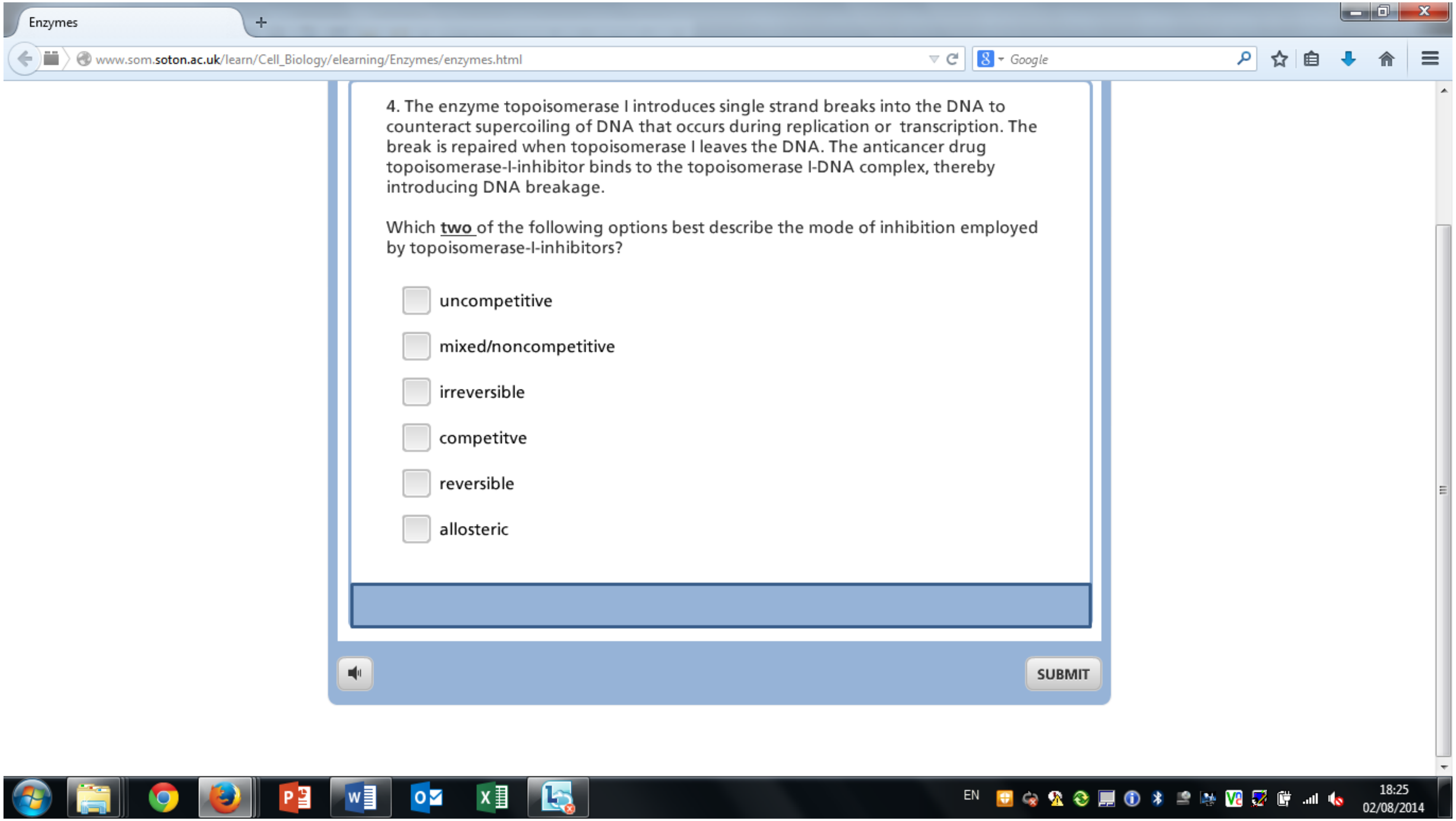
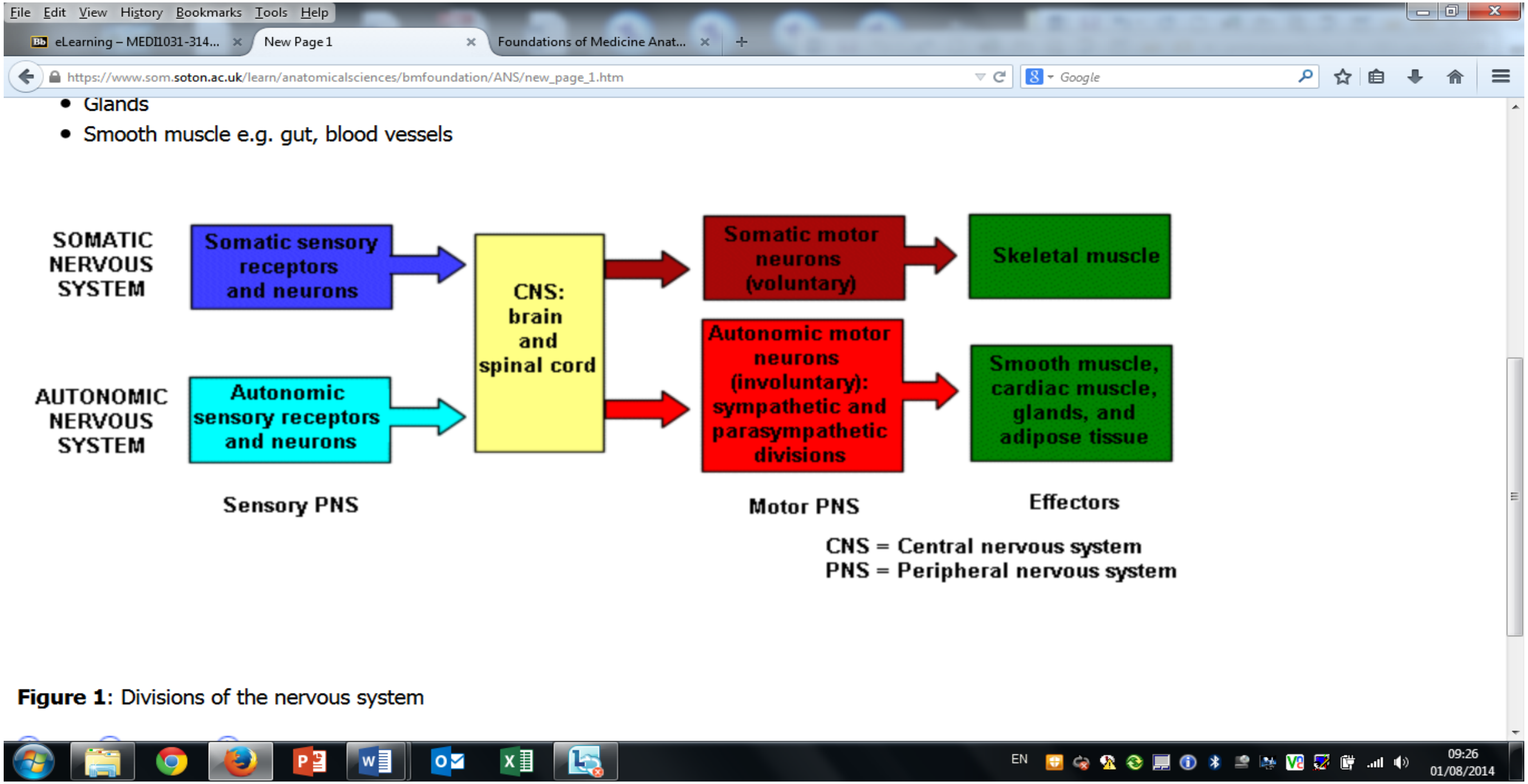
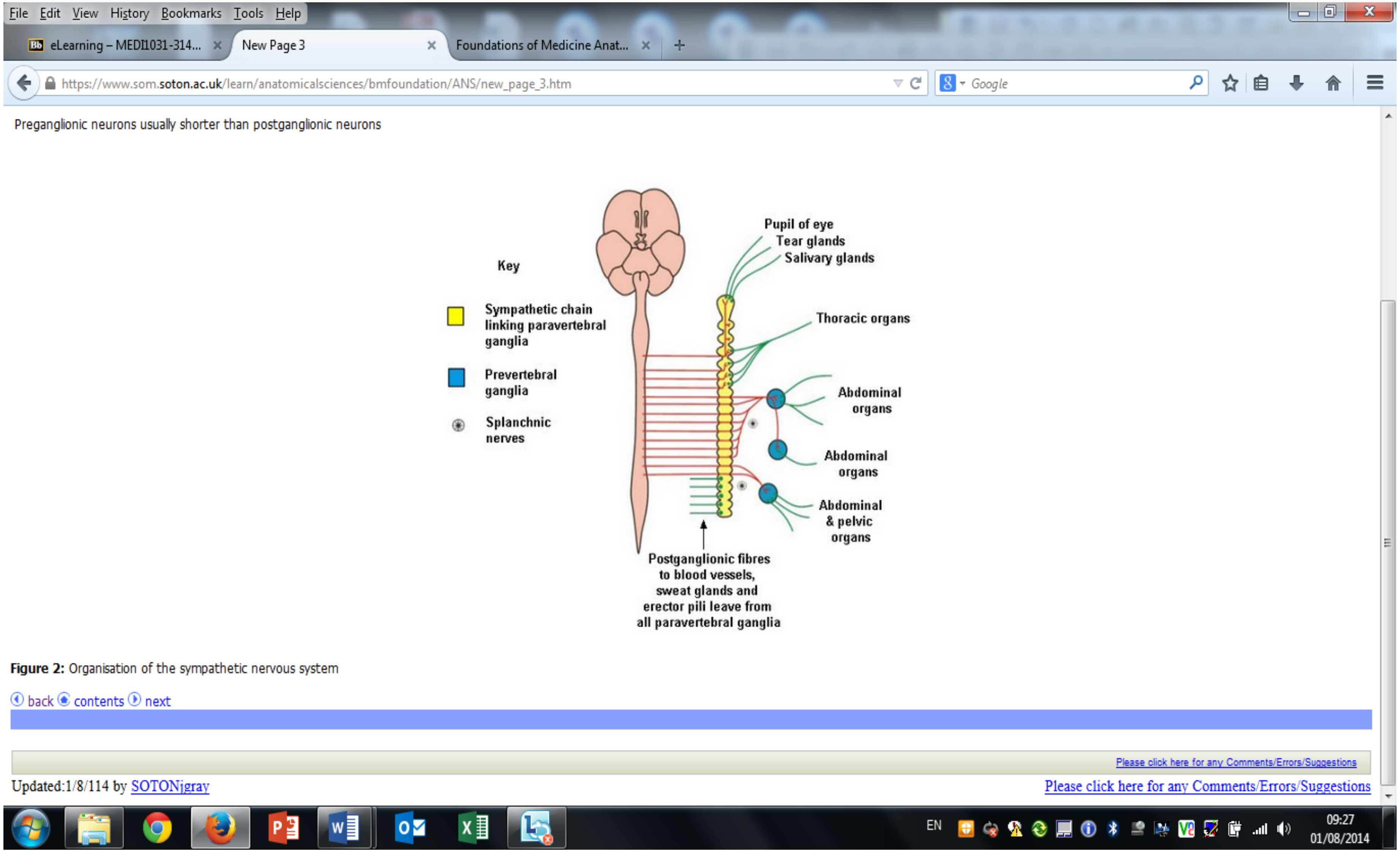
Google
3. Bacteria need an enzyme called transpeptidase for cell wall synthesis. The antibiotic penicillin reacts with a serine residue at the active site of the transpeptidase thereby permanently preventing the normal substrate from binding. This results in a weak bacterial cell wall and ultimately the death of the bacteria.
Which of the following options best describes the mode of inhibition by which penicillin works?
reversible
mixed/noncompetitive
competitive
allosteric
uncompetitive
irreversible
SUBMIT
EN
18:25
02/08/2014


Enzymes
www.som.soton.ac.uk/learn/Cell_Biology/elearning/Enzymes/enzymes.html
Google
4. The enzyme topoisomerase I introduces single strand breaks into the DNA to counteract supercoiling of DNA that occurs during replication or transcription. The break is repaired when topoisomerase I leaves the DNA. The anticancer drug topoisomerase-I-inhibitor binds to the topoisomerase I-DNA complex, thereby introducing DNA breakage.
Which two of the following options best describe the mode of inhibition employed by topoisomerase-I-inhibitors?
uncompetitive
mixed/noncompetitive
irreversible
competitve
reversible
allosteric
SUBMIT
EN
18:25
02/08/2014

Appendix H Samples from the Online e-Learning Materials

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Foundations of Medicine Anat...
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Google
Preganglionic neurons usually shorter than postganglionic neurons
Key
Sympathetic chain linking paravertebral ganglia
Prevertebral ganglia
Splanchnic nerves
Pupil of eye
Tear glands
Salivary glands
Thoracic organs
Abdominal organs
Abdominal organs
Abdominal & pelvic organs
Postganglionic fibres to blood vessels, sweat glands and erector pili leave from all paravertebral ganglia
Figure 2: Organisation of the sympathetic nervous system
back contents next
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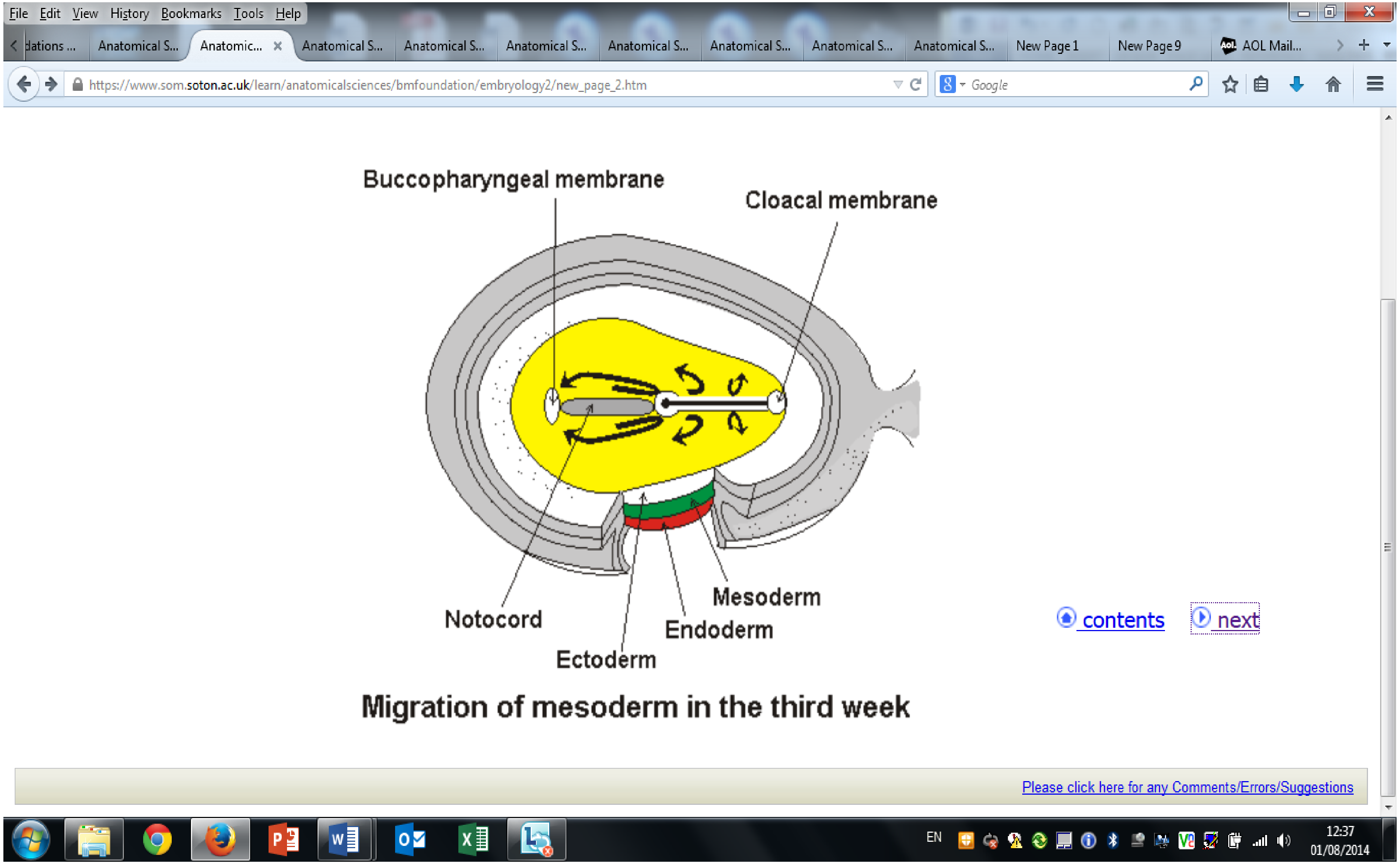
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Buccopharyngeal membrane
Cloacal membrane
Notocord
Mesoderm
Endoderm
Ectoderm
Migration of mesoderm in the third week
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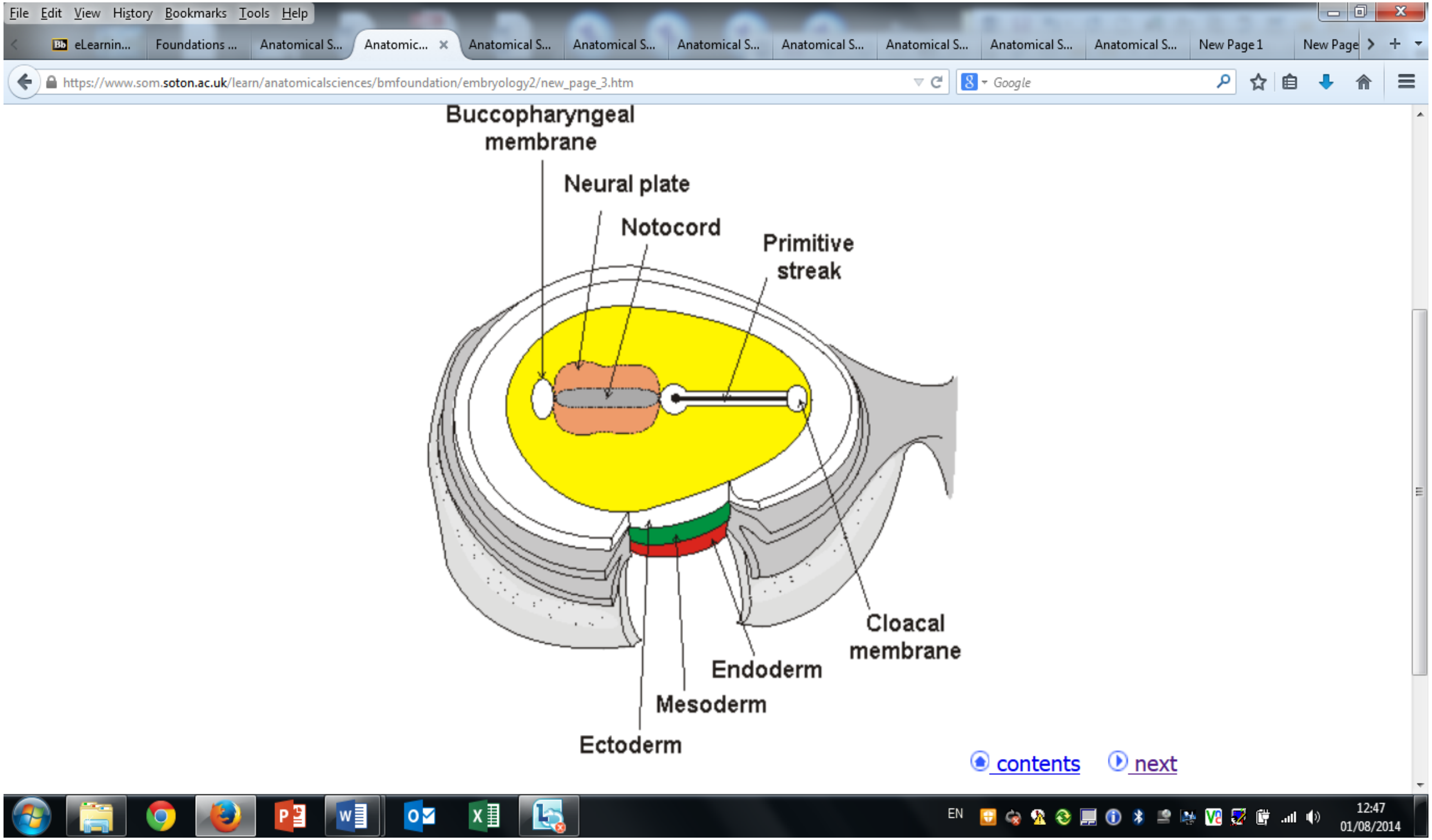
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Neural plate
Notocord
Primitive streak
Cloacal membrane
Endoderm
Mesoderm
Ectoderm
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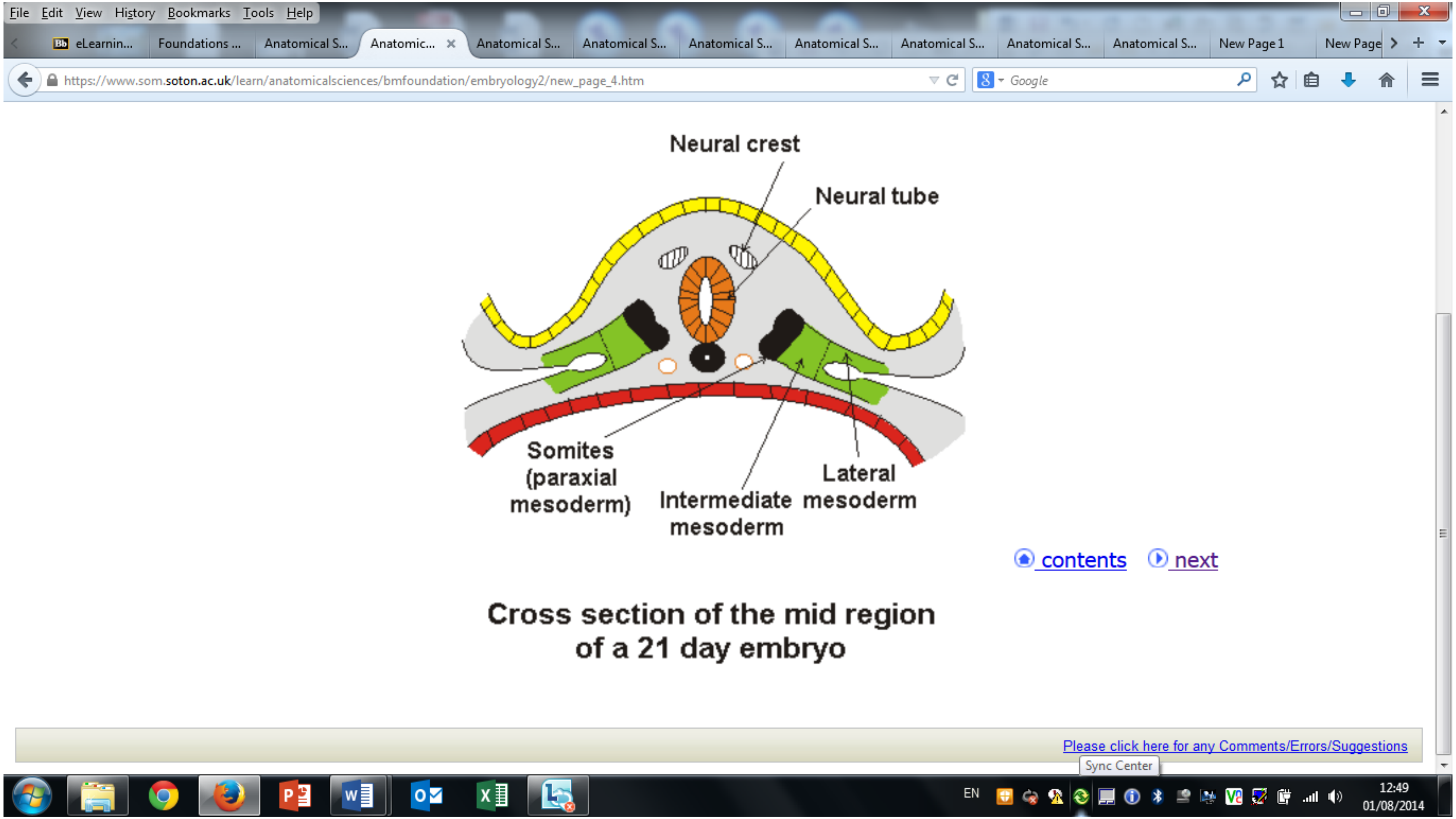
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Neural tube
Somites
(paraxial
mesoderm)
Intermediate
mesoderm
Lateral
mesoderm
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Cross section of the mid region
of a 21 day embryo
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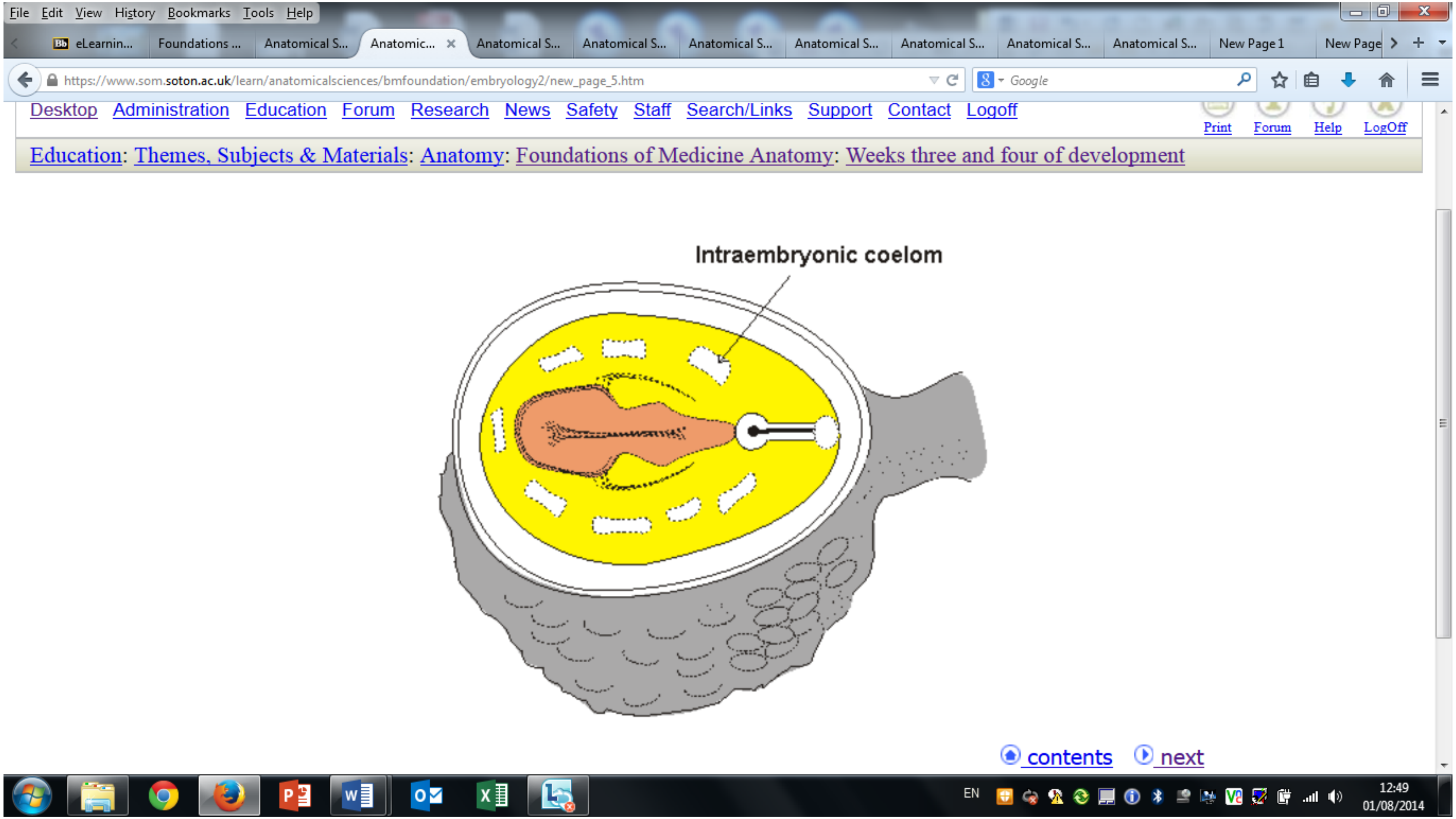
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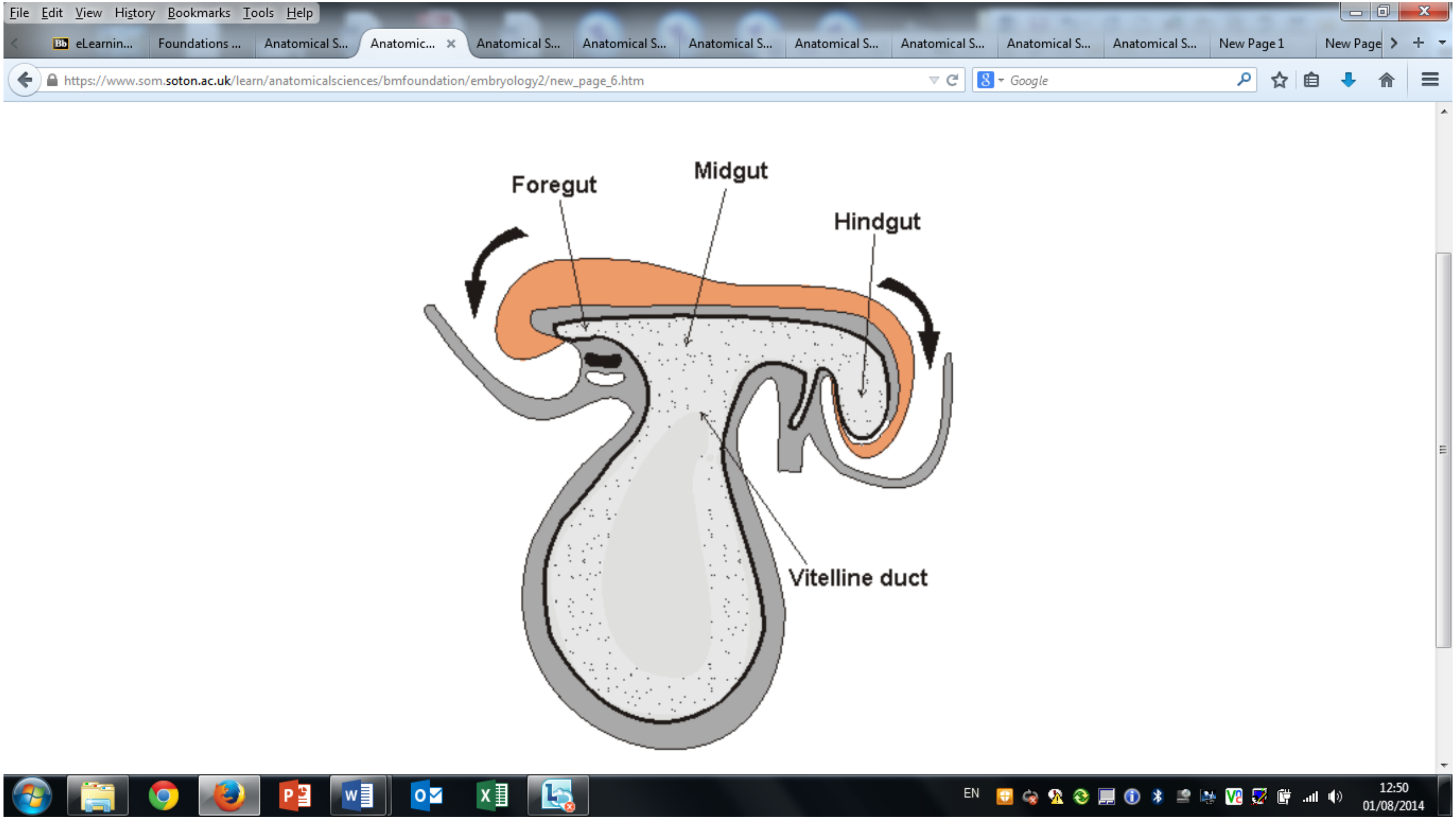
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Midgut
Hindgut
Vitelline duct
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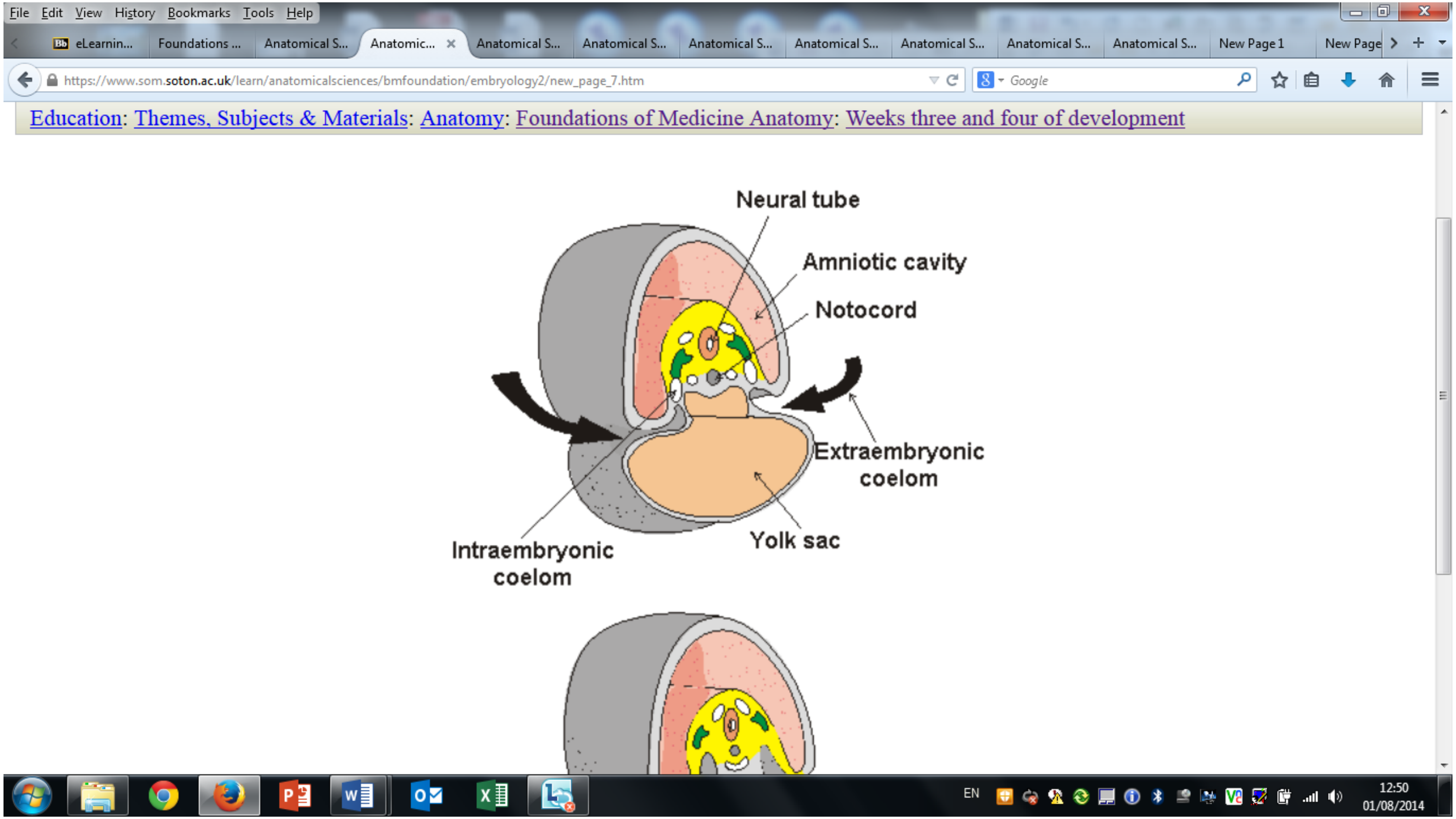
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Education: Themes, Subjects & Materials: Anatomy: Foundations of Medicine Anatomy: Weeks three and four of development
Neural tube
Amniotic cavity
Notocord
Extraembryonic coelom
Yolk sac
Intraembryonic coelom
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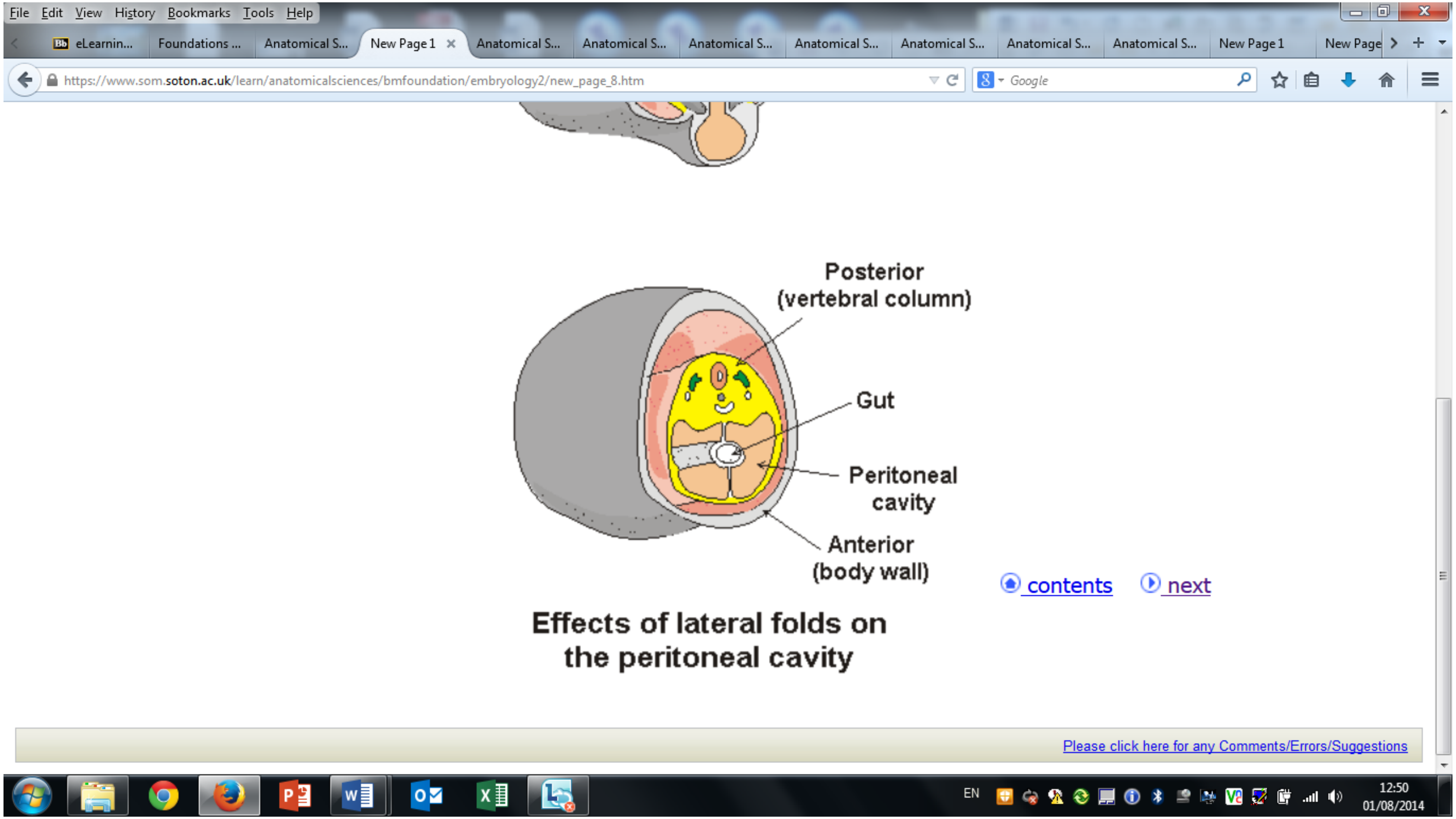
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Posterior
(vertebral column)
Gut
Peritoneal
cavity
Anterior
(body wall)
contents
next
Effects of lateral folds on
the peritoneal cavity
Please click here for any Comments/Errors/Suggestions
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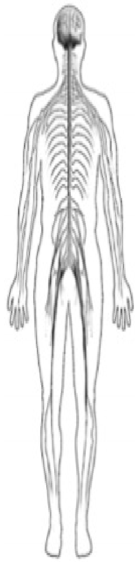
Appendix I Samples from PowerPoint Lecture Presentations

Autonomic nervous system
Lecture III

Distribution of ! and adrenoceptors

! $_1$-adrenoceptors are found in blood vessels of the skin and GI tract where they cause vasoconstriction

! $_2$-adrenoceptors are found on pre-synaptic cells and inhibit the release of neuro-transmitters



$_1$-adrenoceptors found in the heart where they increase the rate and force of contraction

$_2$-adrenoceptors are located in bronchial and uterine smooth muscle where they cause muscle to relax

They are also present on the blood vessels in skeletal muscle where they cause vasodilation

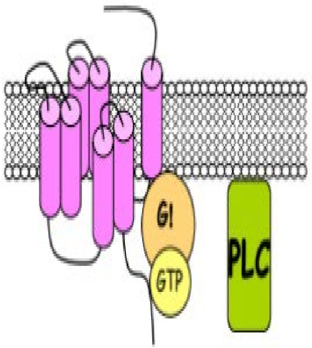
Effects of stimulating !$_1$-adrenoceptors

!$_1$-adrenoceptors are found in blood vessels and smooth muscle

Stimulation results in vasoconstriction and constriction of the smooth muscle **except** in the *GI* tract

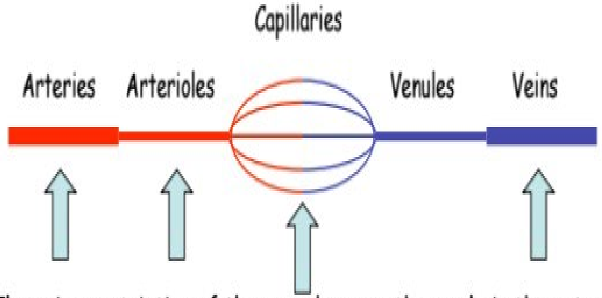
!$_1$-adrenoceptors activate phospholipase *C*

!$_1$-adrenergic receptors



!$_1$-adrenoceptors activate phospholipase *C*

Effects of stimulating !$_1$ receptors on the vascular smooth muscle



There is constriction of the vascular smooth muscle in the arterioles, arteries and veins

This leads to increased peripheral resistance, decreased vascular compliance and increased central venous pressure

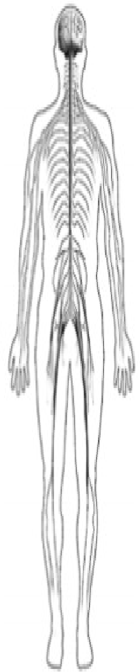
There is an increase in systolic and diastolic arterial pressure

!$_1$-adrenoceptor antagonists and hypertension

- Selective !$_1$-adrenoceptor antagonists such as **doxazosin** and **prazosin** cause vasodilation and a fall in arterial pressure
- They are used in treating resistant hypertension
- They have long plasma half lives so can be taken once a day
- Side effects can include postural hypotension and erectile dysfunction

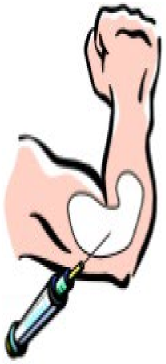
Other uses of !$_1$-adrenoceptor antagonists

Doxazosin and other !$_1$-adrenoceptor antagonists relax smooth muscle in benign prostatic hyperplasia improving urinary flow

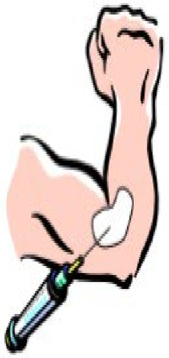


There is also evidence that !$_1$-adrenoceptors play a role in the trophic response that occurs in hypertension and !$_1$-adrenoceptor antagonists may prevent these changes occuring

Use of ! $_{1}$-adrenoceptor agonists: Local anaesthetics

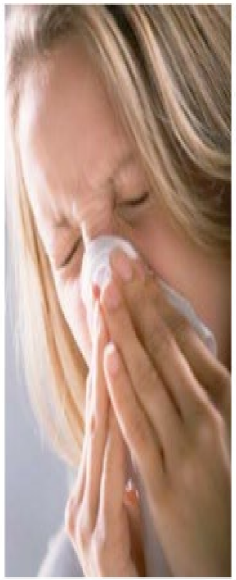


Inject lidocaine



Inject lidocaine with adrenaline

Use of ! $_{1}$-adrenoceptor agonists: Nasal decongestants



The parasympathetic nervous system controls glandular secretion and causes vasodilation

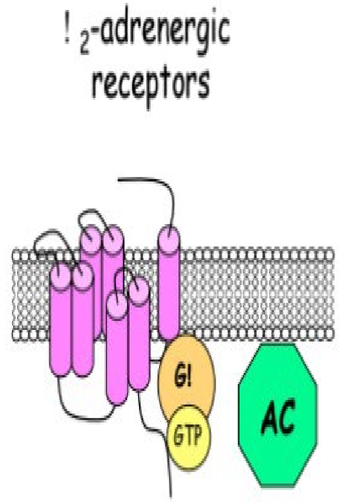
The sympathetic nervous system causes vasoconstriction

! $_{1}$-adrenoceptor agonists such as **pseudoephedrine** and **oxymetazoline** will decrease nasal secretions by constricting blood vessels in the nose

Other decongestants

Parasympatholytic agents such as atropine will also reduce nasal secretions but because atropine is readily absorbed via the nasal mucosa it has too many side effects to be a useful decongestant

! $_2$-adrenoceptors



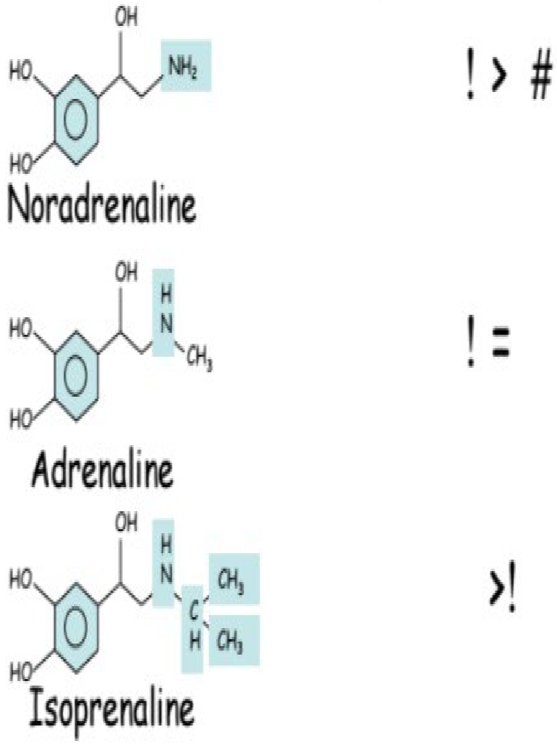
! $_2$-adrenoceptors are located on the **pre-synaptic cell** and act to inhibit the release of noradrenaline via inhibition of adenylate cyclase

! $_2$-adrenoceptors inhibit adenylate cyclase and decrease cAMP levels within the cell

! $_2$-adrenoceptor agonists and hypertension

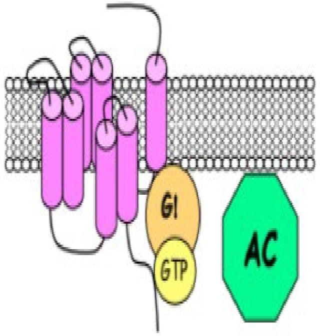
- Selective ! $_2$-adrenoceptor agonists such as **clonidine** will inhibit the release of NA and can be used to treat resistant hypertension
- Methylnoradrenaline will also activate ! $_2$-adrenoceptors and its precursor **methyl dopa** may also be used in resistant hypertension

Drugs acting on - adrenoceptors



-adrenoceptors

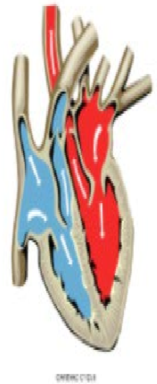
-adrenergic receptors



All the -adrenoceptors activate adenylate cyclase and increase cAMP levels within the cell

$_1$ and $_2$ adrenoceptors differ in their distribution and their agonist and antagonist profiles

Distribution of -adrenoceptors

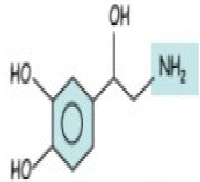


$_1$-adrenoceptors are found in the heart

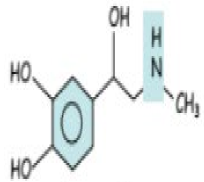
$_2$-adrenoceptors are found in the airway smooth muscle

-adrenoceptor agonists

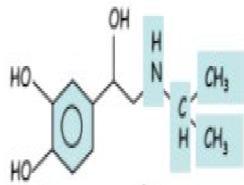
- Adding bulky groups to N-atom increases selectivity for -adrenoceptors and also leaves them less susceptible to uptake 1



Noradrenaline



Adrenaline



Isoprenaline

Effects of $_1$-adrenoceptor agonists

- Increase heart rate (chronotropic effects) and force of contraction (inotropic effects)
- Reduce cardiac efficiency
- Can help to restore automaticity
- Can also disturb cardiac rhythm and ischaemic heart is much more susceptible to these dysrhythmias

Uses and side effects of $_1$-adrenoceptor agonists

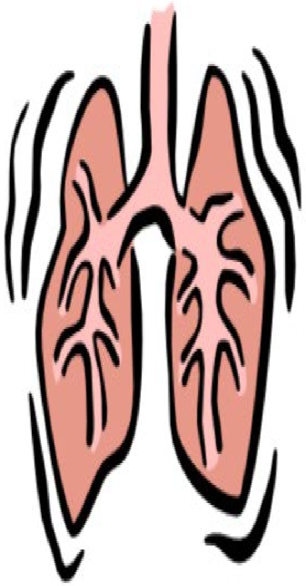
Dobutamine is a $_1$-agonist used acutely to stimulate the failing heart

Slightly more effective at simulating inotropic effects than chronotropic

High incidence of dysrhythmia

Also reduces cardiac efficiency as O_2 consumption increases more than cardiac work

Effects of $_2$-adrenoceptor agonists



Relax airway smooth muscle by acting directly on the $_2$-receptors to increase intracellular cAMP levels

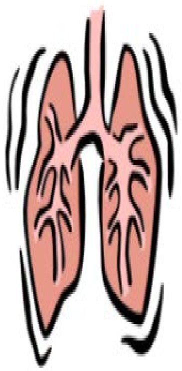
They are effective regardless of the constricting stimulus

This is useful in asthma where more than one broncho-constrictor substance may be present

Use of $_2$-adrenoceptor agonists

Salbutamol is used to relieve the symptoms of asthma

$_2$-agonists are also used in COPD but are much less effective in chronic obstructive lung disease



$_2$-adrenoceptor agonists do not affect underlying airways inflammation in asthma and over reliance on this form of therapy should be avoided

-adrenoceptor agonists in premature labour

- -agonists such as **salbutamol** relax uterine smooth muscle and can be given as an infusion to delay delivery
- This allows the mother to receive steroid therapy to mature the baby's lungs

-adrenoceptor antagonists

- Effects of -blockers such as **propranolol** depend on the levels of sympathetic activity
- -blockers have little effect on resting heart rate, cardiac output or arterial pressure under normal circumstances but will blunt the effects of exercise on these variables
- Exercise tolerance will be reduced because of effects on the heart and the loss of vasodilation in skeletal muscle

Use of -adrenoceptor antagonists: Hypertension

- Hypertension is a complex multifactorial condition and reducing mild, asymptomatic hypertension has been shown to prevent heart attacks and stroke
- -blockers reduce hypertension by
  - Reducing cardiac output
  - Reducing sympathetic activity
  - Modifying renin release

Use of $_1$-adrenoceptor antagonists

While $_1$-adrenoceptor agonists are used to stimulate the failing heart $_1$-adrenoceptor **antagonists** are also used to treat angina pectoris

They work by improving oxygenation of the heart muscle

They are also used to regulate dysrhythmias

Side effects of -blockers

- **Bradycardia** - can become life threatening in patients with coronary disease
- **Hypoglycaemia** - glucose release in response to adrenaline is blocked
- **Fatigue** - reflects reduced cardiac output and exercise tolerance
- **Cold extremities** - due to loss of -adrenoceptor induced vasodilation

Side effects of -blockers: Bronchoconstriction

- -blockers can not be used by asthmatics who use -agonists for symptomatic relief
- -blockers have minimal effects on patients with normal airways function

Use and abuse of -blockers

- -blockers such as **propranolol** are also used as anxiolytics
- They will modulate autonomic symptoms such as palpitations and tremor
- They have been widely used (and abused) to treat stage fright

Appendix J Samples From Tutorial Notes

Clinical Pharmacology BM5 Foundation Course:

Pharmacology Tutorial: The Autonomic Nervous System

Queries: email (email deleted). You will probably need to use your notes and a good textbook to prepare for this tutorial.

MCQ (answer true or false)

Acetylcholine is a transmitter substance released by all postganglionic nerve endings in the parasympathetic nervous system. T/F

The receptors on the organ cells (postsynaptic receptors) that are being innervated by the parasympathetic postganglionic nerve endings are nicotinic receptors. T/F

Acetylcholine acts to stimulate muscarinic and nicotinic receptors. T/F

The nerves that cause sweating following the release of acetylcholine from their nerve endings at sweat glands are parasympathetic nerves.T/F

Problem

Before an operation, the drug atropine is sometimes given. Atropine is an antagonist which selectively blocks muscarinic receptors and prevents the neurotransmitter, acetylcholine, from stimulating them and producing an effect on the organ.

What are muscarinic receptors, where are they found and what is their physiological effect?

What effect will atropine have on: Pupil diameter?

Heart rate? Salivary secretions?

Bronchial secretions?

Bronchial smooth muscle contractility? Sweating?

Gut contractility? Bladder emptying?

What effect will atropine have on receptors for acetylcholine in

a) ganglia b) neuromuscular junctions

Sometimes an individual might be poisoned by drugs like atropine. What effect would you expect? What could be done to counteract the effects of the poisoning? Give the type of drug used and how it works. If this antidote is not given correctly, it too can cause poisoning. What effects would you expect to see with this, and in what occupation could poisoning with this class of drug occur?

While salmon fishing in Canada you stumble across a brown bear (*Ursus arctos*) taking a nap in the woods. While making your hurried escape, you notice that you are experiencing a classic 'fight or flight' reaction. What are the effects of sympathetic activation on (a) the heart, (b) the bronchial airways, (c) the liver, (d) blood vessels in the skin, gut and skeletal muscle, and (e) the pupil, and what are the adrenergic receptors responsible for each response?

a. *Clostridium botulinum* is an anerobic bacterium which may contaminate poorly sterilized tinned foods, especially meats. What is its active ingredient? What effect does it have in man? Can it ever be injected into a person for clinical purposes?

The puffer fish is a delicacy in Japan. However, it contains a deadly poison and must be prepared only by specially trained chefs. What is this poison? What does it do to nerves?

In 2002, Tesco denied using Black Widow spiders to reduce the need for pesticides in its fruit orchards overseas. Such spiders occasionally turn up in baskets of supermarket fruit in the UK. What would be the effects of being bitten by a Black Widow spider?

If a patient is untreated, what is the common mechanism of death for all three of the above?

Appendix K Participant Information Sheet (PIS) (Receptive and Productive Tasks)

Southampton

01/11/2014/Ethics ID:9877

Information about the Research for Student Participants *(Version.1.1, Last Updated: 01/11/2014)*

Title of the Project: Students' Acquisition of Medical English (SAME)

Researcher's contact details: Stavroula El. Gkarampliana (seg1g12@soton.ac.uk)

Aim of the study: This research study examines medical students' degree of awareness and usage of **a)** technical lexis (i.e. specialised vocabulary) and **b)** sub-technical lexis (i.e. more general academic vocabulary) that first year Medicine students are introduced to. The study focuses on how students develop their knowledge and use of medical vocabulary during the module *Foundations of Medicine*. Its aim is to enhance our understanding of potential differences in awareness and usage of the two types of vocabulary between students and cohorts (e.g. some BM6 students receive medical glossary wordlists in year 0, BM (EU) students may struggle with English but may have taken Latin at school).

Classroom Data Collection Process:

1. Firstly, students will be asked to complete a pre-test (September 2014) and a post-test (January 2015) evaluating their awareness of medical vocabulary that they are introduced to during the module. The test is based on wordlists that have been developed from digital analysis of sources such as: recommended textbooks (i.e. BM5 Program booklist), SCALPEL, PiPs, PowerPoint presentations and e-learning materials developed for the course. The resultant one-page test will take approximately 8 minutes and should be completed in the lecture theatre. Students will be asked to indicate their student number only, not their name.
2. Secondly, the researcher will analyse students' *productive vocabulary*, i.e. by establishing whether students are actually using the new words in their *Foundations of Medicine* essay and in their answers to exam questions. Again, this data will only contain student numbers, so that participant anonymity is maintained.
3. Lastly, a small number of student volunteers will be interviewed about their approaches to learning medical English (n=10).

Confidentiality: All information sources that will be used for the conduct of this study will be kept confidential and in line with the Data Protection Act 1998 and 2003. Details and related information about the students will be kept strictly anonymous and will be held securely in a password-protected computer in order to prevent unauthorised access.

Participation: Students may participate voluntarily in the research study and they have the right to withdraw at any moment without providing a reason. **Participants should be aware that this study focuses only on their language knowledge and that none of the language data gathered for the project will have any impact on their assessment but will be used only for research purposes.**

Complaints: If something goes wrong, or you wish to have further information concerning any aspect of this study, participants should either discuss it with the researcher or contact the supervisory team (contact details are provided below).

Outcomes: Once the study is completed, the results will be included in the PhD thesis (expected completion: September 2016) and copies will be available.

Researcher		**Supervisory Team**
PhD student Stavroula El. Gkarampliana Modern Languages (seg1g12@soton.ac.uk)	Prof. Patrick Stevenson, Modern Languages (P.R.Stevenson@soton.ac.uk)	Dr Anja Timm, Faculty of Medicine, Medical Education Development Unit (a.timm@soton.ac.uk)

Appendix L Consent Form (Receptive and Productive Tasks

Medicine

UNIVERSITY OF Southampton

CONSENT FORM *(Version.1.1, Last Updated: 01/11/2014)*

Study title: Students' Acquisition of Medical English (SAME)

Researcher name: Stavroula El. Gkarampliana

Study reference: N/A

Ethics reference: 9877

Please initial the box(es) if you agree with the statement(s):

I have read and understood the information sheet (1st/11/2014) and have had the opportunity to ask questions about the study. ☐

I permit the researcher to collect my data on pre-task, post-task and written essays ☐

Name of participant (print name)…………………………………………………

Signature of participant……………………………………………………………..

Date………………………………………………………………………………

Name of researcher (print name)…………………………………………………

Signature of researcher ……………………………………………………………..

Date………………………………………………………………………………

Appendix M Sample of a Lexical Profiling on the MEDREC TS AND ORS Combined

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
1	TYPE	RANGE	FREQ	MEDREC TS	BNC1	BNC2	BNC3	BNC4	BNC5	BNC6	BNC7	BNC8	BNC9	BNC10	BNC11	BNC12	BNC13	BNC14	BNC15	BNC16	AWL&SL	Not in the lists/Tech	
2	PROCESSOR	2	25	24	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3	PROLIFERATING	2	25	24	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	
4	PROLIFERATIVE	2	25	24	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	
5	MALFORMATION	2	6	5	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	
6	MANAGES	2	6	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
7	MICROBE	2	6	5	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	
8	MILES	2	6	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
9	MILLILITRE	2	6	5	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
10	MISCONDUCT	2	6	5	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	
11	MISNOMER	2	6	5	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	
12	MISTAKEN	2	6	5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
13	INFINITY	2	2	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	
14	APOPTOSIS	1	420	420	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
15	CYTOKINES	1	348	348	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
16	AGONIST	1	345	345	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
17	RETICULUM	1	340	340	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
18	AORTIC	1	331	331	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
19	MICROGRAPH	1	315	315	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
20	LACTAMASE	1	309	309	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
21	ENDOPLASMIC	1	301	301	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
1	TYPE	RANG	FREI	MEDREC	BNC'	BNC	BNC	BNC	BNC!	BNC	BNC	BNC	BNC	BNC1	BNC1	BNC1	BNC1:	BNC1	BNC1!	BNC1	AWL&!	**Not in**	**the lists/Tech**	
2	PROCESSOF	2	25	24	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
3	PROLIFERAT	2	25	24	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0		
4	PROLIFERAT	2	25	24	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0		
5	MALFORMAT	2	6	5	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0		
6	MANAGES	2	6	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
7	MICROBE	2	6	5	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0		
8	MILES	2	6	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
9	MILLILITRE	2	6	5	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
10	MISCONDUC'	2	6	5	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0		
11	MISNOMER	2	6	5	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0		
12	MISTAKEN	2	6	5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
13	INFINITY	2	2	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0		
14	APOPTOSIS	1	420	420	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1		
15	CYTOKINES	1	348	348	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1		
16	AGONIST	1	345	345	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1		
17	RETICULUM	1	340	340	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1		
18	AORTIC	1	331	331	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1		
19	MICROGRAPI	1	315	315	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1		
20	LACTAMASE	1	309	309	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1		
21	ENDOPLASM	1	301	301	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1		
22	ANTIMICROB	1	293	293	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1		
23	GOLGI	1	289	289	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1		
24	VERONAL	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
25	VERRILL	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
26	VESICULARIZ	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
27	VICALLY	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
28	VIGILANTLY	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
29	VINBLASTIN	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
30	VINCULIN	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
31	VINORELBINI	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
32	VIRGILI	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
33	COMMENTAF	3	3	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0		
34	COMMENTA'	3	3	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0		
35	COMMENTEI	3	3	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0		
36	COMMITS	3	3	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0		

Appendix N Sample of a Lexical Coverage Output

Sample 1

Word Type	Rank	Frequency	Cumulative Percent
THE	1	114087	5.36
OF	2	80433	9.14
AND	3	58431	11.89
TO	4	44908	14.00
IN	5	43120	16.02
A	6	36659	17.75
IS	7	30608	19.19
ARE	8	19213	20.09
FOR	9	16090	20.84
BY	10	14947	21.55
WITH	11	14508	22.23
THAT	12	14452	22.91
OR	13	13505	23.54
BE	14	13400	24.17
AS	15	13368	24.80
THIS	16	11521	25.34
ON	17	10620	25.84
IT	18	8266	26.23
WHICH	19	8108	26.61
FROM	20	7869	26.98
CAN	21	7772	27.35
AN	22	7597	27.70
CELL	23	7186	28.04
CELLS	24	7129	28.38
NOT	25	5969	28.66
HAVE	26	5885	28.93

Sample 2

DIARRHOEA	674	442	61.71
DISTRIBUTION	675	441	61.
HOST	676	441	61.75
STILL	677	441	61.77
VARIETY	678	441	61.79
CORONARY	679	439	61.81
DEVELOP	680	438	61.83
VIRUSES	681	437	61.85

BEST	682	435	61.87
INHIBITS	683	435	61.89
KINASE	684	435	61.91
GLANDS	685	433	61.93
POSITION	686	433	61.95
FORMED	687	432	61.97
POOR	688	432	61.99
EVENTS	689	431	62.01
MAINLY	690	431	62.03
DECREASED	692	428	62.07
TRUE	693	428	62.09
BETA	694	427	62.11
ACTING	695	426	62.13
GET	696	426	62.15
INTRODUCTION	697	426	62.17
PULMONARY	698	426	62.19
ENVIRONMENT	699	425	62.21
LONGER	700	425	62.23
COMMENTS	701	424	62.25
SYMPATHETIC	702	423	62.27
WHITE	703	423	62.29
ADDITIONAL	704	422	62.31
ASK	705	422	62.33
CONTRACTION	706	422	62.35
JUST	707	422	62.37
LIMITED	708	422	62.39
SYSTEMIC	709	422	62.41
ADMINISTRATION	710	421	62.43
SURGICAL	711	421	62.45
APOPTOSIS	712	420	62.47
EVERY	713	420	62.49
GASTRIC	714	420	62.51
REPORT	715	420	62.53
HYDROGEN	716	419	62.55
MASS	717	419	62.57
ELECTRON	718	416	62.59
MANAGEMENT	719	416	62.61
SIGNAL	720	415	62.63
MODEL	721	413	62.65

CANNOT	722	412	62.67
LEAST	723	412	62.69
PHOSPHATE	724	412	62.71
STOMACH	725	411	62.73
LEADS	726	410	62.74
LOCATION	727	409	62.76
WEEKS	728	409	62.78
AMOUNT	729	408	62.80
EXPERIENCE	730	408	62.82
DIFFERENCES	731	406	62.84
SMOKING	732	405	62.86
COMPLETE	733	404	62.88
RESPONSIBLE	734	404	62.90
STEP	735	404	62.92
DURATION	736	403	62.94
SERVICES	737	403	62.95
SOMETIMES	738	403	62.97
TIMES	739	403	62.99
STAINING	740	402	63.01
RATES	741	401	63.03
STABLE	742	401	63.05
TOXIC	743	401	63.07
TOO	745	400	63.11
ABDOMINAL	746	399	63.12

<u>Sample 3</u>

POWERFUL	2455	119	80.00
RUPTURE	2456	119	80.00
SKULL	2457	119	80.01
STREPTOGRAMINS	2458	119	80.01
TITLE	2459	119	80.02
VARIABLES	2460	119	80.02
AMPHOTERICIN	2461	118	80.03
AMYLOID	2462	118	80.04
ATOMIC	2463	118	80.04
BOTTOM	2464	118	80.05
CLINICIAN	2465	118	80.05
ECONOMIC	2466	118	80.06
EXISTS	2467	118	80.06
FIXATION	2468	118	80.07

FORWARD	2469	118	80.07
LINKING	2470	118	80.08
NONE	2471	118	80.09
NORADRENALINE	2472	118	80.09
PERSPECTIVE	2473	118	80.10
PINK	2474	118	80.10
PLAQUE	2475	118	80.11
PRECURSORS	2476	118	80.11
PYRIMIDINES	2477	118	80.12
SEPARATED	2478	118	80.12
BELIEFS	2480	117	80.14
COMPLETED	2481	117	80.14
CONCLUSION	2482	117	80.15
CONSIST	2483	117	80.15
CREATE	2484	117	80.16
DALFOPRISTIN	2485	117	80.16
DISCRETE	2486	117	80.17
EXTENSORS	2487	117	80.17
HANDLING	2488	117	80.18
INNATE	2489	117	80.19
MESSENGER	2490	117	80.19
OUTPUT	2491	117	80.20
PLANES	2492	117	80.20
PROMOTER	2493	117	80.21
QUINUPRISTIN	2494	117	80.21
SECRETIONS	2495	117	80.22
TOWARD	2497	117	80.23
BACKGROUND	2499	116	80.24
CANCERS	2500	116	80.25
CYTOCHROME	2501	116	80.25
DEPOLARIZATION	2502	116	80.26
DIHYDROFOLATE	2503	116	80.26
ENCODED	2504	116	80.27
INADEQUATE	2505	116	80.27
LIQUID	2506	116	80.28
LISTED	2507	116	80.28
LYMPHOMA	2508	116	80.29
OCCUPATIONAL	2509	116	80.29
RELATIONSHIPS	2510	116	80.30

ROUTES	2511	116	80.31
SEEMS	2512	116	80.31
ANALGESIA	2513	115	80.32
CARRIES	2514	115	80.32
CENTURY	2515	115	80.33
CHEMOKINES	2516	115	80.33
COAGULATION	2517	115	80.34
COMBINATIONS	2518	115	80.34
DIAGNOSES	2519	115	80.35
ELEMENT	2520	115	80.35
FEMUR	2521	115	80.36
FLEXOR	2522	115	80.36
INTEGRITY	2523	115	80.37
LIGANDS	2524	115	80.38
LUMBAR	2525	115	80.38
PEPTIDOGLYCAN	2526	115	80.39
PERFORMANCE	2527	115	80.39
SEGMENTS	2528	115	80.40
SHARE	2529	115	80.40
SUBCUTANEOUS	2530	115	80.41
SYNTHETASE	2531	115	80.41
TEMPORAL	2532	115	80.42
TERTIARY	2533	115	80.42
TODAY	2534	115	80.43
TOOLS	2535	115	80.44
UNLIKE	2536	115	80.44
VARIATIONS	2537	115	80.45
CANAL	2538	114	80.45
CHALLENGE	2539	114	80.46
CONTINUED	2540	114	80.46
COPIES	2541	114	80.47
DETECTION	2542	114	80.47
DEVELOPS	2543	114	80.48
EOSIN	2544	114	80.48
FLU	2545	114	80.49
FRONT	2546	114	80.49
HEME	2547	114	80.50
HOMEOSTASIS	2548	114	80.50
LARGELY	2549	114	80.51

PARALLEL	2550	114	80.52
REPLACEMENT	2551	114	80.52
RESPONSIBILITY	2552	114	80.53
SERVE	2554	114	80.54
SYNDROMES	2555	114	80.54
SYNOVIAL	2556	114	80.55
TRANSFERENCE	2557	114	80.55
ATTACK	2558	113	80.56
COPING	2560	113	80.57
EXPENDITURE	2561	113	80.57
GENITAL	2562	113	80.58
INVESTIGATION	2563	113	80.58
NEUROPATHY	2565	113	80.60
OESTROGEN	2566	113	80.60
OSTEOARTHRITIS	2567	113	80.61

<u>Sample 4</u>

MEDULAR	35900	1	99.75
MEDWAY	35901	1	99.75
MEGA	35903	1	99.75
MEGABASE	35904	1	99.75
MEGALO	35905	1	99.75
MEGALY	35906	1	99.75
MEHMO	35907	1	99.75
MEIRA	35908	1	99.75
MEISUREMENT	35909	1	99.75
MELANOCYTE	35910	1	99.75
MELASAND	35911	1	99.75
MELD	35912	1	99.75
MELENA	35913	1	99.75
MELINDA	35914	1	99.75
MELL1TUS	35915	1	99.75
MELNIKOVA	35916	1	99.75
MELTZER	35917	1	99.75
MEMANTINE	35919	1	99.75
MEME	35924	1	99.75
MEMES	35925	1	99.75
MENDENHALL	35926	1	99.75
MENIERE	35927	1	99.75
MENINGI	35928	1	99.75

MENINGIOMA	35929	1	99.75
MENINGITIDISN	35930	1	99.75
MENINGITIS175	35931	1	99.75
MENINGOCOCCIS	35932	1	99.75
MENLEN	35933	1	99.75
MENMENO	35934	1	99.75
MENSES	35935	1	99.75
MENSTURATION	35936	1	99.75
MENTATION	35937	1	99.75
MENTORS	35938	1	99.75
MEPAZINE	35939	1	99.75
MEPERIDINE	35940	1	99.75
MEPHENYTOIN	35941	1	99.75
MEPYRAMINE	35942	1	99.75
MERCAPTAN	35943	1	99.75
MERCAPTANS	35944	1	99.75
MERCHANDISE	35945	1	99.75
MERGED	35946	1	99.75
MERGENCE	35947	1	99.75
MERGER	35948	1	99.75
MERGES	35949	1	99.75
MERLO	35950	1	99.75
MEROCTINE	35951	1	99.75
MEROZO1TE	35952	1	99.75
MERTON	35954	1	99.75
MESENCEPHALON	35955	1	99.75
MESENCHYMA	35956	1	99.75
MESENCHYMALSTEM	35957	1	99.75
MESENTERIES	35958	1	99.75
MESHES	35959	1	99.75
MESILATE	35960	1	99.75
MESODUODENUM	35961	1	99.75
MESONEPHROS	35962	1	99.75
MESORIDAZINE	35963	1	99.75
MESWARAN	35964	1	99.75
METENKEPHALIN	35965	1	99.75
METAANALYSIS	35966	1	99.75
METABOLISABLE	35967	1	99.75
METABOLYTE	35968	1	99.75

METACARPAL	35969	1	99.75
METACARPALPHALYNGEAL	35970	1	99.75
METACARPOPLWLANGEAL	35971	1	99.75
METACONSTRUCT	35972	1	99.75
METADISTURBANCE	35973	1	99.75
METALFILM	35974	1	99.75
METALFOPROTEINASES	35975	1	99.75
METALLOELASTASE	35976	1	99.75
METALLOELASTASES	35977	1	99.75
METALLOPROTEASES	35978	1	99.75
METANEPHROS	35979	1	99.75
METAPHORICAL	35980	1	99.75
METAPHYSES	35981	1	99.75
METAPNEUMOVIRUSNIPAH	35982	1	99.75
METASTASISED	35983	1	99.75
METASTASISES	35984	1	99.75
METATARSOPHALANGEAL	35985	1	99.75
METAZOAN	35986	1	99.75
METAZOANGLOBINS	35987	1	99.75
METENKEPHALIN	35988	1	99.75
METEORIC	35989	1	99.75
METHEMOGLOB	35990	1	99.75
METHEMOGLOBINEM	35991	1	99.75
METHEMOGLOBINEMIA	35992	1	99.75
METHYLAMINOMETHYL	35994	1	99.75
METHYLASE	35995	1	99.75
METHYLATING	35996	1	99.75
METHYLENETETRAHYDROFOLATE	35997	1	99.75
METHYLPYRAZOLE	35998	1	99.75
METHYLTETRAHYDROPTEROYLTRIGLUTAMATE	35999	1	99.75
METHYLTRANSFEREASES	36000	1	99.75
METHYSERGIDE	36001	1	99.75
METICULOUS	36002	1	99.75
METRONIDAZOLEINTERACTS	36003	1	99.75
MEVACOR	36004	1	99.75
MIAMIMIAMI	36017	1	99.75
MIBEFRADIL	36018	1	99.75
MICROAEROPHILIC	36023	1	99.75
MICROANEURYSM	36024	1	99.75

MICROBIOME	36025	1	99.75
MICROBODIES	36026	1	99.75
MICROCHANNEL	36027	1	99.75
MICROCIRCUIT	36028	1	99.75
MICROCIRCULATION	36029	1	99.75
MICRODUPLICATIONS	36030	1	99.75
MICROEMBOLI	36031	1	99.75
MICROENVIRONRNENT	36032	1	99.75
MICROENVIRORUNENTS	36033	1	99.75
MICROGRAM	36034	1	99.75
MICROINFARCTS	36035	1	99.75
MICROINJECTION	36036	1	99.75
MICROMOLE	36037	1	99.75
MICROMONOSPORA	36038	1	99.75
MICRONEEDLES	36039	1	99.75
MICRONOR	36040	1	99.75
MICROPHTHALMIA	36041	1	99.75
MICROPLICAE	36042	1	99.75
MICROPROCESSOR	36043	1	99.75
MICROSCOPISTS	36044	1	99.75
MICROSITE	36045	1	99.75
MICROSOMAL	36046	1	99.75
MICROTEARS	36047	1	99.75
MICROTHROMBI	36048	1	99.75
MICROTUTULES	36049	1	99.75
MICROUTRIENTS	36050	1	99.75
MICROVILL	36051	1	99.75
MIDCYCLE	36056	1	99.75
MIDDLESBROUGH	36057	1	99.75
MIDLIFE	36058	1	99.75
MIDREGION	36059	1	99.75
MIGHTIEST	36064	1	99.75
MIGRAINES	36065	1	99.75
MIGRANSOTHERS	36066	1	99.75
MIGRATED	36067	1	99.75
MIKOSHIBA	36069	1	99.75
MILET	36072	1	99.75
MILGROM	36073	1	99.75
MILIEUS	36074	1	99.75

MILKIE	36075	1	99.75
MILL	36076	1	99.75
MILLET	36078	1	99.75
MILLIEQUIVALENT	36079	1	99.75
MILLIMETRE	36080	1	99.75
MILLIMOLE	36081	1	99.75
MILLIONLIVES	36083	1	99.75
MILLSTONE	36087	1	99.75
MILY	36088	1	99.75
MIMICKED	36089	1	99.75
MIMICKING	36090	1	99.75
MINATION	36092	1	99.75
MINDERS	36093	1	99.75
MINDSETS	36094	1	99.75
MINERGIC	36095	1	99.75
MINGLE	36096	1	99.75
MINIATURE	36097	1	99.75
MINIMALZATION	36098	1	99.75
MINIMS	36099	1	99.75
MINISTER	36101	1	99.75
MINISTRIES	36102	1	99.75
MINORMAJOR	36105	1	99.75
MINOT	36106	1	99.75
MINUTELY	36107	1	99.75
MIOTIC	36108	1	99.75

Appendix O Sample Wordlist Output From 60-100% Lexical Coverage

PROPAGATES
PROPELLED
PROPRIOCEPTORS
PROSECTIONS
PROSTATECTOMY
PROTOFILAMENTS
PSEUDOPOD
PULOMONIC
STETHESCOPES
STIMULATOR
STRATA
STREAMING
STRENGTHENED
STREPTOLYSIN
SUBMAXIMAL
SUBSPECIALIST
SUBTOTAL
SUBTRACTION
SUBTYPE
SUFFIXES
SUPPOSITORY
SUPRANUCLEAR
SURPRISE
SUTURES
SYMPORT
SYNAPES
TEMPORALLY
TENDINOUS
TENSIONS
TERATOGENS
TERMINOLOGIES
TETRACAINE
TETRAHYDRO
THALLIUM
THANATOPHORIC
THERMOMETER
THIOESTER
THIOPURINE
TIBIOFEMORAL
TIEDEMANN
TIMETABLED
TOLERANT
TOLUENE
TRACHOMA
TRANSCRIPTOME
TRANSDERMALLY
TRANSDUCED
TRANSFUSE
TREMATODES
TRICHOMONAS
TRIPEPTIDE
TRITIUM
TROPHIC
TURBULENCE
TUSSIVE
TYRAMINE
ULTRASONIC
BETALACTAM
BICIPITAL
BIDIRECTIONAL
BIMODAL
BIOAVAILABLE
BIOENERGETICS
BIOMARKER
BISPHOSPHO
BLADDERS
BORDERED
BRACHIA
BRADYKINESIA
BRANCHIAL
BRONCHITIC
BULLECTOMY
CALCULUS
CALICIVIRUSES
CANALISE
CANCELLOUS
CATALYZING
CATEGORICAL
CATHODE
CAVEOLIN
CAVERNOSA
CEFACLOR
CEFIXIME
CENTIMETERS
CENTRIFUGATION
CERAZETTE
CERULOPLASMIN
CHAPERONINS
CHARACTERISING
CHARITIES
CHELATING
CHRONOS
CIRCULATED
CITATIONS
CLINDAMYCIN
CLINICALMED
CLONORCHIASIS
CLOUDING
CLOVIR
COEXISTENT
COEXISTING
COHESION
COMMINGLE
COMMONER
COMPILED
COMPLIMENTARY
CONCEPTIONS
CONCIOOUSNESS
CONCLUDES
CONDYLOID
CONFIRMATORY
CONJUNCTIVITS
CONSENTED
CONSEQUENTIAL
CONSOLIDATE
CONTRACTIITY
CONTRASTED
CONVERGENT
CONVERSATIONS
CONVULSANT
CONVULSANTS
CORNERSTONE
CORPUSCULAR
CORRECTIONS
CORROBORATE
CORTIOSPINAL
CORTISONE
COTRANSPORT
COXIELLA
CREAMS
CRESTS
CRIMINAL
CROSSTALK
CRYPTS
CULMINATES
CURATIVE
CURSORY
CYANOSED
CYCLICAL
CYSTICERCOSIS
CYTES
CYTOGENETICS
CYTOLYTIC
DARKENING
DASHBOARD
DEACETYLATED
DEADLINE
DEBATED
DEBRIEFING
DECIDES
DECLARATION
DECOMPOSES
DECREMENT
DECREMENTS
DEDUCE
DEFECATE
DEFORMED
DEGENERATING
DEGRESS
DELAYING
DELIBERATELY
DEMISE
DENATURE
DEPLOARISING
DEPOLARIZES
DEPRESSIONS
DEPROTONATED
DERIVATION
DERIVING
DESIGNS
DESOGESTREL
DESTRUCT
DETAILING
DETAINED
DETECTABILITY
DETERIORATED
DETOXIFIED
DEXTRANS
DIARREHA
DIATHESIS
DICLEMENTE
DIDINIUM
DIETICIAN
DIFFERENTIALS
DIFFUSELY
DILANTIN
DINUCLEOTIDES
DIPEPTIDE
DIPLOTENE
DIPYRIDAMOLE
DISASTERS
DISCERNED
DISCRIMINATE
DISCRIMINATIVE
DISINTERESTED
DISOPYRAMIDE
DISPENSED
DISRUPTIONS
DISRUPTIVE
DISSIMILAR
DISSIPATION
DISTALLY
DISTINCTLY
DISTORT
DISTORTING
DISTORTION
DIVERTICULUM
DOMINANTLY
DRAINING
DRASTIC
DRESSED
DRIES
DUCHENNE
DUCTAL
DUMPS
DWELLING
DYDRAMOL
DYSMOTILITY
DYSTONIA
ECB
ECONAZOLE
EFFERENTS
EHRLICHIOSIS
EIGHTY
ELECTIVELY
ELECTRODES
ELECTROPHYSIOL
OGY
ELEVATIONS
ELLS
ELONGATING
ELUCIDATE
ELUCIDATING
EMBDEN
EMINENCES
EMIT
EMPHASISING
EMULSION
ENCAPSULATE
ENDONUCLEASES
ENDOTHELINS
ENDOTOXIC
ENDPLATES
ENDPOINT
ENDURING
ENGLYST
ENGULFS
ENSUE
ENTACTIN
ENTEROBIASIS
ENTEROCYTES
EPIGLOTTITIS
EQUILIBRATED
EQUILIBRATION
EQUITY
EROSIONS
ERRECTILE
ERYTHEMATOUS
ESBL
ESOPHAGITIS
EVEREST
EVIDENTLY
EXACERBATED
EXONUCLEASES
EXPEL
EXPLANATORY
EXPO
EXPONENT
EXQUISITE
EXTRANEOUS
EXTRAORDINARY
FACTORING
FAIRNESS
FALK
FAMILIARITY
FAMOUS
FASCICULATA
FASCINATING
FASCIULATIONS
FEASIBILITY
FIBRILLARY
FIBRINOLYTICS
FLACCIDNESS
GALLSTONE
GENIOGLOSSUS
GLUCURONIDE
GLYCAM
GONADOTROPINS
HAEMORRHAGES
HEMATOLOGICAL
MONOGENETIC
MONOSOMIC
MONOSOMIES
MONOTHERAPY
MONOZYGOTIC

Appendix P The Receptive Vocabulary Recogniton Pre-Task (Projected Example Version)

ID n.__________________ **Age:**_________ **Gender:** Male Female

UNIVERSITY OF Southampton

Your native language(s) ____

Other language(s) you speak:____

Your highest qualification in English (if it's not your native language):__________________________

Circle the programme you are registered on:

BM6
BM5
BM (EU)
Repeating year 1

Have you taken any of the following exams? (please circle):			
A Levels:	**Abitur**	**A BA degree**	**Other**
Chemistry	Chemistry	(specify subject)	**Qualification(s)**
Biology	Biology	___________	___________

Please tick if you have studied either of the following classical languages: ☐ Latin ☐ Greek

Tick (☑) next to the word(s) that you know (the first item is provided as an example only).

medical	☑	exon		influenza		ticarcillin		cytognostic	
arthritis		warfarin		vancomycin		cilia		emphysema	
reagents		corticosteroids		stem		metronidazole		dermatome	
diuretics		solute		abnormalities		lactomiologic		endocytosis	
anaphilia		inhibitory		lactams		oocyte		atelectasis	
basodies		substrict		glyoxylate		spectrum		aeruginosa	
antimicrobial		hydrophobic		equilibrium		piperacillin		peptide	
golgi		afferent		fibrotraumatic		mosmol		phosphorylated	
otitis		strands		angina		aetiology		catalase	
pathogenic		endoplasmic		nutridence		electron		clostridium	
hepatitine		encephalopathy		synaptic		globerium		conundrum	
haematoxylin		procystic		atlas		acetaldehyde		staphaureus	
residues		codeine		aneurysms		emphiminate		attrition	
codon		dynethics		sacral		amoxicillin		vials	
infectides		carboxichemicals		buccal		oestrogenomic		doxycycline	
topical		cornea		analgesic		melanomas		physioincision	
medial		haematopoietic		apoptosis		histamines		teleczema	
antiblasts		pulmonary		antenatal		cutaneous		fluctuating	
antifungal		carbendectomy		cefuroxime		arteriosclerosis		amnesiac	
flexion		melatonin		alveoli		ribosomes		amoxiclav	
clot		genomic		diastolic		splinter		saccular	
atoms		atrophic		obesity		meiosis		optisitric	
posterior		thalamic		constrict		oestrogen		cyclosporin	
homeostasis		teicoplanin		bilirubin		transvalves		stenosis	
phenotype		ions		nuclei		dendrites		micrograph	
dysfunction		endometrial		trisomy		bradypnoea		moxifloxacin	
mucosal		aconiate		catheters		pyrimidines		epithelioid	
deficiency		anaesthetic		induced		rubella		tricepsylase	
substrates		amorphous		gonadotropin		capsulated		sphingomyelin	
pharmacokinetics		peptoglycan		pulmones		epidermal		cathepsin	
allele		controlent		salicylic		hybridizine		basophilic	
bactericidal		cochrane		gonorrhydia		affinity		anxiolytic	
histocode		bacteraemias		hepatomegaly		significant		vesicles	
enterica		colitis		mechanodesmiotic		morphylates		splachnic	
bile		trancreased		lipophilic		microvilli		sarcomere	
anteriolateral		arctire		cardioxide		basis		vecuronium	
swelling		stomen		streptococci		peptidoglycan		intake	
mechanoneuroses		intestinal		polyrectent		cholangitis		neurons	
rinse		karyorrhexis		acidesium		rates		inhibit	
hypoxia		hemothermia		ribonthetic		allantoic		glocrease	

*Please provide an email if you are willing to take part in a 10 mins interview:____________________

Thank you for your participation!

Appendix Q The Receptive Vocabulary Recognition Post-Task (Projected Example Version)

ID n.__________________ **Age:**__________ **Gender:** Male Female

UNIVERSITY OF Southampton

Are you an ex-BM6 student who is now in the BM5 program? (circle) Yes No

Tick (☑) next to the word(s) that you know (the first item is provided as an example only).

medical	☑	exon		influenza		ticarcillin		cytognostic	
arthritis		warfarin		vancomycin		cilia		emphysema	
reagents		corticosteroids		stem		metronidazole		dermatome	
diuretics		solute		abnormalities		lactomiologic		endocytosis	
anaphilia		inhibitory		lactams		oocyte		atelectasis	
basodies		substrict		glyoxylate		spectrum		aeruginosa	
antimicrobial		hydrophobic		equilibrium		piperacillin		peptide	
golgi		afferent		fibrotraumatic		mosmol		phosphorylated	
otitis		strands		angina		aetiology		catalase	
pathogenic		endoplasmic		nutridence		electron		clostridium	
hepatitine		encephalopathy		synaptic		globerium		conundrum	
haematoxylin		procystic		atlas		acetaldehyde		staphaureus	
residues		codeine		aneurysms		emphiminate		attrition	
codon		dynethics		sacral		amoxicillin		vials	
infectides		carboxichemicals		buccal		oestrogenomic		doxycycline	
topical		cornea		analgesic		melanomas		physioincision	
medial		haematopoietic		apoptosis		histamines		teleczema	
antiblasts		pulmonary		antenatal		cutaneous		fluctuating	
antifungal		carbendectomy		cefuroxime		arteriosclerosis		amnesiac	
flexion		melatonin		alveoli		ribosomes		amoxiclav	
clot		genomic		diastolic		splinter		saccular	
atoms		atrophic		obesity		meiosis		optisitric	
posterior		thalamic		constrict		oestrogen		cyclosporin	
homeostasis		teicoplanin		bilirubin		transvalves		stenosis	
phenotype		ions		nuclei		dendrites		micrograph	
dysfunction		endometrial		trisomy		bradypnoea		moxifloxacin	
mucosal		aconiate		catheters		pyrimidines		epithelioid	
deficiency		anaesthetic		induced		rubella		tricepsylase	
substrates		amorphous		gonadotropin		capsulated		sphingomyelin	
pharmacokinetics		peptoglycan		pulmones		epidermal		cathepsin	
allele		controlent		salicylic		hybridizine		basophilic	
bactericidal		cochrane		gonorrhydia		affinity		anxiolytic	
histocode		bacteraemias		hepatomegaly		significant		vesicles	
enterica		colitis		mechanodesmiotic		morphylates		splachnic	
bile		trancreased		lipophilic		microvilli		sarcomere	
anteriolateral		arctire		cardioxide		basis		vecuronium	
swelling		stomen		streptococci		peptidoglycan		intake	
mechanoneuroses		intestinal		polyrectent		cholangitis		neurons	
rinse		karyorrhexis		acidesium		rates		inhibit	
hypoxia		hemothermia		ribonthetic		allantoic		glocrease	

Please circle the answer that best describes you:

- How important is it to pay attention to the medical vocabulary you use in academic essays?

1.Not important at all	2.A little important	3.Somehow important	4.Very important	5.Absolutely important

- Which area was most challenging for you?

1.Learning new medical vocabulary when reading/listening to lectures	2.Using the new medical vocabulary in written essays	3.Both	4.Other_________________

Rate from 1 (=too much relied) – 7 (= poorly relied) the following resources depending on how much you relied on them for your learning of medical vocabulary during sem. 1.

- ☐ Medical dictionary
- ☐ Medical textbooks
- ☐ Lecture slides
- ☐ Pips
- ☐ SCLAPEL
- ☐ Internet websites (please provide an example):______________________________
- ☐ Other (please mention): ______________________________

Appendix R Sample Data Entry and Calculation of Pre-task and Post-task Data

Technical	word	pre task		post task		Sutechnical	Word	pre task		post task		Imaginary Word	pre task	post task
Band 1	POSTERIOR	1		1		Band 1	STEM	1		1		ACIDESIUM		
	PULMONARY	1		1			ATOMS	1		1		ANAPHILIA		
	NEURONS	1		1			RATES			1		ANTIBLASTS		
	APOPTOSIS			1			SIGNIFICANT	1				ARCTIRE		
	INFLUENZA	1		1			ABNORMALITIES	1		1		BASODIES		
	IONS	1		1			ANGINA	1		1		CARBENDECTOMY		
	PEPTIDE	1		1			ELECTRON	1		1		CARBOXICHEMICALS		
	VESICLES	1		1			SPECTRUM	1		1		CARDIOXIDE		1
	INHIBIT	1		1			OBESITY	1				CONTROLENT		
	INTAKE	1		1			BASIS	1		1		CYTOGNOSTIC		
TOTAL			**9**		**10**	**TOTAL**			**9**		**8**	DYNETHICS		
Band 2	ENDOPLASMIC			1		Band 2	NUCLEI	1		1		EMPHIMINATE		
	GOLGI	1		1			AFFINITY	1		1		FIBROTRAUMATIC		
	INDUCED	1		1			ARTHRITIS	1		1		GLOBERIUM		
	RESIDUES	1		1			SWELLING	1		1		GLYCORCHROMIA		
	RINSE	1		1			DEFICIENCY	1		1		GLOCREASE		

	WARFARIN	1		1			DYSFUNCTION	1		1		GONORRHYDIA		
	VANCOMYCIN			1			MEDIAL	1		1		HEMOTHERMIA		
	INTESTINAL	1		1			MICROGRAPH	1				HEPATITINE		
	METRONIDAZOLE						ANAESTHETIC	1		1		HISTOCODE		
	AMOXICILLIN	1		1			ANTIMICROBIAL	1		1		HYBRIDIZINE		
TOTAL			**7**		**9**	**TOTAL**			**10**		**9**	INFECTIDES		
Band 3	PEPTOGLYCAN	1		1		Band 3	ALVEOLI	1		1		LACTOMIOLOGIC		
	SYNAPTIC	1		1			BACTERAEMIAS					MECHANONEUROSES		
	HYDROPHOBIC	1		1			ANTIFUNGAL	1		1		MECHANODESMIOTIC		
	LIPOPHILIC			1			BUCCAL					MORPHYLATES		
	GLYOXYLATE			1			ANTERIOLATERAL			1		NUTRIDENCE		

	DENDRITES	1		1			ANXIOLYTIC					OESTROGENOMIC		1
	STENOSIS						CATHEPSIN					OPTISITRIC		
	THALAMIC						ARTERIOSCLEROSIS					PHYSIOINCISION		1
	ENTERICA						BRADYPNOEA					POLYRECTENT		
	GONADOTROPIN	1		1			CAPSULATE			1		PROCYSTIC		
TOTAL			**5**		**7**	**TOTAL**			**2**		**4**	PULMONES		

Band 4	MEIOSIS	1		1	
	RIBOSOMES				
	CUTANEOUS			1	
	VECURONIUM			1	
	MICROVILLI	1		1	
	PIPERACILLIN				
	TEICOPLANIN				
	DOXYCYCLINE	1		1	
	CEFUROXIME				
	EMPHYSEMA	1		1	
TOTAL			4		6
Band 5	OESTROGEN	1		1	
	EPIDERMAL	1		1	
	OOCYTE	1		1	
	MUCOSAL			1	
	TOPICAL	1		1	
	SACRAL	1		1	
	TICARCILLIN				
	PYRIMIDINES			1	
	DIASTOLIC	1			

Band 4	EQUILIBRIUM	1		1	
	ENDOCYTOSIS	1		1	
	CILIA	1		1	
	LACTAMS			1	
	AFFERENT			1	
	CORTICOSTEROIDS			1	
	FLEXION	1		1	
	BACTERICIDAL	1			
	REAGENTS	1		1	
	DIURETICS	1		1	
TOTAL			7		9
Band 5	OTITIS				
	PHARMACOKINETICS			1	
	SUBSTRATES	1		1	
	GENOMIC	1		1	
	PEPTIDOGLYCAN				
	BILE	1		1	
	CODON			1	
	INHIBITORY	1		1	
	HOMEOSTASIS	1		1	

RIBONTHETIC		
STOMEN		
SUBSTRICT		
TELECZEMA		
TRANCREASED		
TRANSVALVES		
TRICEPSYLASE		
GRAND TOTAL	0	3

	COLITIS						STRAND			1	
TOTAL			6		7	TOTAL			5		8
Band 6	RUBELLA	1		1		Band 6	SOLUTE	1		1	
	STREPTOCOCCI			1			ALLELE	1		1	
	TRISOMY	1		1			PATHOGENIC	1		1	
	EXON	1		1			CONSTRICT	1			
	HAEMATOXYLIN	1					PHENOTYPE	1		1	
	AETIOLOGY			1			CLOT	1		1	
	CODEINE	1		1			ENCEPHALOPATHY				
	HYPOXIA	1		1			CORNEA	1		1	
	CLOSTRIDIUM	1		1			ATLAS	1		1	
	DERMATOME			1			PHOSPHORYLATE	1		1	
TOTAL			7		9	TOTAL			9		8
Band 7	MOSMOL			1		Band 7	CATHETERS	1		1	
	ACETALDEHYDE	1		1			AERUGINOSA				
	SALICYLIC						COCHRANE				
	HEPATOMEGALY	1					ANEURYSMS	1		1	
	SPHINGOMYELIN						CATALASE	1		1	
	BASOPHILIC	1		1			AMORPHOUS	1		1	
	AMOXICLAV			1			ENDOMETRIAL	1		1	

	SARCOMERE			1	
	MELATONIN	1		1	
	EPITHELIOID			1	
TOTAL			4		7
Band 8	SACCULAR				
	STAPHAUREUS			1	
	ATELECTASIS				
	SPLACHNIC			1	
	ACONIATE				
	ALLANTOIC				
	CYCLOSPORIN				
	CHOLANGITIS				
	MOXIFLOXACIN				
	KARYORRHEXIS				
TOTAL		42	0	57	2
GRAND TOTAL		**55%**		**60%**	

	BILIRUBIN				
	HAEMATOPOIETIC			1	
	ATROPHIC			1	
TOTAL			5		7
Band 8	ANTENATAL	1		1	
	VIALS	1		1	
	ANALGESIC	1		1	
	ATTRITION	1		1	
	CONUNDRUM	1		1	
	HISTAMINES	1		1	
	MELANOMAS			1	
	AMNESIAC	1		1	
	FLUCTUATING	1		1	
	SPLINTER	1		1	
TOTAL		56	9	63	10
GRAND TOTAL		**64%**		**64%**	

Appendix S Sample of 4 Matched Pre-tasks and Post-tasks

(to ease the process of analysis, all scores were converted into a percentage (%)

student #	Pretask HIT%-tech	FA%-tech	**Isdt-tech**	Posttask HIT%-tech	FA%-tech	**Isdt-tech**	**Pretask** HIT%-Sub	FA-Sub	**Isdt-sub**	**Posttask** HIT%-Sub	FA-Sub	**Isdt-sub**
26710218	0.3875	0.0125	**51%**	0.675	0.0375	**67%**	0.6125	0.0125	**66%**	0.6125	0.0125	**66%**
26787997	0.65	0.05	**64%**	0.825	0.025	**81%**	0.9	0.05	**85%**	0.9	0.03125	**85%**
2675457	0.475	0	**58%**	0.6375	0.00625	**68%**	0.725	0	**76%**	0.775	0.00625	**76%**
25923994	0.42	0	**55%**	0.57	0.03	**60%**	0.56	0	**64%**	0.63	0.03	**64%**

Appendix T The Selection of the Algorithm for the Results Calculation of the Yes/No Test

This section broadly discusses the issue of algorithm and the process of selection of the most appropriate algorithm to mark all medical students answers based on their score. A total number of 4 algorithms are presented here among with examples in order to facilitate the decision that was made on the most suitable algorithm to satisfy the purposes of this study.

The Yes/No test or else checklist is suggestive for vocabulary size (Pellicer-Sanchez and Schmitt, 2012); it requires students to read a word and show if they are familiar with it or not. One of its major advantages is that it has the capacity of using a quite short time to engage a large number of test takers on a numerous lexical items (Beeckmans et al., 2001; Mochida and Harrington, 2006). Except for the fact that such types of tests have the great advantage of recruiting a large number of participants (Nation, 1990), the answers required by the students do not need to be elaborated (Harrington and Carey, 2009) since students are simply asked to fill in a checklist, the way it looks is clear and results were not expected to negatively affect the students (Meara, 1990). Apart from this, numerous studies tested the effectiveness of the yes/no test against other methods of evaluating vocabulary size reaching to the conclusion that there seem to be significant correlations between the yes/no test and a multiple choice test (r.=50) (Anderson and Freebody, 1983; Harrington and Carey, 2009; Meara and Buxton, 1987; Meara and Jones, 1988; Mochida and Harrington, 2006). On the other hand, the correlation between this type of testing against productive lexical knowledge were not significant (Cameron, 2002; Eyckmans, Van de Velde, van Hout and Boers, 2007).

Moreover, critics of the yes/no tests suggested that it may be the case that L2 learners, especially the ones with low level of English, may give different responses to the test compared to the L1 English speakers (Meara, 1990; 1994). Apart from this, it is challenging to measure polysemous items (Anderson and Freebody, 1983) and it is not easy to test whether the testee provides honest answers (Meara, 2010). It should be noted here that all Hits and FAs were converted into percentages and then decimals in order to ease calculations and follow-up comparisons.

#	Hits	F	Hits %	FA%	H-FA	Cfg	Δm	Isdt
1	*10/80*	*0/40*	*0.13*	*0.00*	*0.13*	*0.13*	*-7.88*	*0.39*
2	*20/80*	*3/40*	*0.25*	*0.18*	*0.18*	*0.19*	*-3.81*	*0.29*
3	*30/80*	*5/40*	*0.38*	*0.13*	*0.25*	*0.29*	*-2.38*	*0.31*
4	*40/80*	*6/40*	*0.50*	*0.08*	*0.35*	*0.41*	*-1.59*	*0.38*
5	*50/80*	*8/40*	*0.63*	*0.20*	*0.43*	*0.53*	*-1.07*	*0.43*
6	*60/80*	*10/40*	*0.75*	*0.25*	*0.50*	*0.67*	*-0.67*	*0.50*
7	*80/80*	*15/40*	*1.00*	*0.38*	*0.63*	*1.00*	*0.00*	*0.68*
8	*80/80*	*0/40*	*1.00*	*0.00*	*1.00*	*1.00*	*0.00*	*1.00*

Table 1: examples of scoring of eight medical students with random sample answers.

As can be seen in the examples presented above, the score often changes depending on the percentage of Hits and False Alarms (FA) each time. On examples 1, 2 and 3, the student ticked on a limited number of hits and had a limited number of false alarms. The results from the four formulas appearing above are similar for the H-FA and the cfg while the Isdt gives credit to the student for their correct rejections to pseudowords since it might be the case that the students' response styles were rather reserved. However, as examples 4-7 demonstrate above, there seems to be a relative similarity in conclusions between the h-fa and the Isdt formula. As far as the Δm is concerned, all responses came out negative indicating the amount of answers. However, it seemed to have reached closer to 0.00 (100%) as the number of hits increases regardless of the amount of False Alarms included in the Hits. Meara's Δm is not meant to be a scores adjustment formula rather than a formula, which helps observe students' scores if they did not tick FAs, thus, it cannot be considered as a scores adjustment formula,

More specifically, the formula H-FA that appears to be the most straightforward one may not be able to detect all correct responses or correct rejections. As can be seen from Table 1, example #1 the student had a 0.13 (13%) of Hits and no non-word responses. Upon calculating the score with the H-FA formula the result *is still 0.13. It appears that in this case the student by having zero FA, he/she had a total of 40 correct rejections to the non-words given which the formula failed to take into consideration. The same applies to all other examples illustrated in Table 1.*

The second formula, cfg=ph-pf/1-pf which has been quite popular in the literature of measuring vocabulary size (Anderson and Freebody, 1983; Meara and Buxton, 1987) appears to have similar findings with the H-FA formula on both examples 1 and 2 presumably due to the low number of test values attributed to both H and FAs. However, in example n. 7 where a student has answered to 80 out of 80 Hits (1.00 or 100%) but ticked on 15 out of 40 nonwords (0.38 or 38%). This is rather high, the final result remains 1.00 or 100% which seems to suggest that the formula failed to take into account the overestimation of the test-taker's knowledge as appearing in the large proportion of non-words selected. It is evident that the results of example 7 are the same as someone's result would be if he/she scored 100% hits and successfully rejected the imaginary words. Since the testee failed to correctly reject a large proportion of imaginary words, it seems that claiming that the student achieved 100% on the test is rather imprecise and as Huibregtse et al. (2002) correctly observed, "it does not meet the conditions of sophisticated guessing and the individual response style" (2002:232).

The Δm formula is based on the Signal Detection Theory (STD), which has been used in the past in lexical tests of word recognition (Hoshino, 1991; MacLeod and Kampe, 1996), as well as lexical knowledge tests (Behrend, 1988). In a yes/no test, the STD takes into account the test takers' stimuli and responses based on an X and Y axis where Y records the FAs and the X records the total number of hits. When the points of the two axons meet each other, they form a curve known as the Receiver Operating Characteristic (ROC) curve where points (0.0) indicates lack of responses while (1.1) indicates a sufficient amount of responses. Green and Moses (1966: 229-230) and Green and Swets (1966: 45-50) demonstrated that under the ROC curve it is possible to see the percent of accurate responses of other possible tests with fixed values on the x and y-axis. Huibregtse et al. (2002) observed that except for the two variables taken into consideration, alterations in the test such as incentives given to testees for more yes answers might bring significant changes in the test results. The Δm measures the total score of the participants if they had not ticked on the nonwords. While this formula is a good *estimate for students' possible score, it fails to provide an amendment to their scores as its' estimates can only function at the FA=0 level thus not giving credit to students' true hits in line with the H-FA and the cfg formulas. The Δm has ranges from the values 0 to 1 and it estimates students' response styles beyond their current probability degree. While it does fulfil the conditions of the STD theory, it fails to adjust the students' final score effectively. Except for the fact that the minus sign may complicate calculations has been discarded by Huibregtse et al. (2002).*

The last alternative is the Istd formula which is related to the basic principles of Meara's (1992) Δm theory for score estimation combined with Grier 1971 theory for X and Y outcome taking them both one step further and concentrating on the Y (total hits score) using the Isdt formula. More specifically, the participants' response style is taken into account as well. As Hodos (1970) correctly points out, one point below on the Y-axis signifies a missed answer to a hit. In this case, the FA is expected to be zero since a student who is in doubt of whether he/she knows the word would answer no. On the other hand, one point below on the X-axis signifies a yes to a non-word, which at the same time signifies that a student's possibility for a Hit (H) equals to one. The resulting curve between the two points signifies the students' score without any bias from the non-words. According to Grier (1971:425) in order to find out the true performance of a test taker, it is necessary to estimate the intersection point between the X and Y-axis and the ROC curve along with the negative diagonal. This calculation can be achieved with the Isdt formula developed by Huibregtse et al. (2002). This formula takes into consideration all three principles for the Signal Detection Theory; for instance, it takes into consideration the students' Hits, False Alarms and response style by calculating their type of responses and giving to students more credits when they successfully make rejections while lower their score when a number of non-words are ticked. As can be seen in Appendix T, Table 1, students who have a low number of FAs tend to be given a higher score (see examples 1 and 2) as it appears that their response style was reserved and they not only rejected the Hits but also they correctly rejected the False Alarms (FA). On the other hand, when test takers' responses are increasing, their FA is increasing too, which means that the participant may have overestimated his/her knowledge; therefore, the formula will reduce the true score (see examples 4 to 7). However, when participants tick on all real words with a zero FA (see example 8) the result will *still be 1.00 (100%) which is fair for students who are genuinely familiar with all real words in a yes/no test.*

Appendix U Sample of a Medical Students' Essay

Introduction

What fatal disease causes half of all suicides in the age range from twenty to thirty-five years? A mental disorder called depression, which embodies the most common mental disorder in today's society, including children, adolescents and students[1-4]. Medical students especially, feature a remarkably high depression rate compared to fellow students in other degree-courses. They embody the future generation of doctors, which will be treating patients, and thus awareness needs to be raised towards this issue[5].

Theories and Models for the Causes of Depression

Although various models for a biological cause of depression exist, this mental disease is considered idiopathic with a plethora of different biological and psychosocial factors that contribute to the manifestation of depression[6]. However, one model has established itself above all existing models, summarizing the main three scientific triggers of this disorder: the biopsychosocial model (Figure 1)[7]. This model incorporates psychological, social, as well as biological components elements[1].

The monoamine-deficiency theory

The monoamine-deficiency theory, which is based on biological causes, comprises persisting shifts in the production of cranially active molecules[6]. As introduced in its name, this theory is based on a decrease in the levels of monoamines[6], such as serotonin (5-HT) and noradrenaline (NA)[8]. The nerve fibres in the limbic system, the prefrontal cortex, and the spinal cord are responsible for the control of mood and pain[8]. Hence, a lack of monoamine levels in these regions will result in abnormalities in the control of mood as a consequence[8]. Furthermore, post mortem studies of depressed individuals have proven a lesser neuronal activity, lesser grey-matter volume and lower density of glial cells in the hippocampus and prefrontal cortex[6,8]. This demonstrates a decrease of one's neuroplasticity in terms of physical shrinkage in volume of the targeted area[8]. These above mentioned regions govern memory, cognition and negative emotions of guilt and worthlessness, which are typically distorted in depression[6,8,9]. Despite these insights, depression remains to be a multicausal disease[8].

The risk of suffering from depression increases with genetic predisposition, which represents a contributing factor in 40-50% of the cases[3]. Furthermore, women - with a 20% chance of developing it throughout their life - are about 1.7 times likelier to suffer from depression than men with a 12% chance[6].

Polymorphism of 5-HTTLPR (the coding gene for of the transporter protein, 5-HTT, responsible for the reuptake of serotonin from the synaptic cleft) can also lead to a reduced serotonin availability in the presynaptic cell[3]. Carriers with a shorter allele do not synthesize the transporter as sufficiently as carriers with the larger allele do[3]. Therefore, less 5-HTT is present and less serotonin is reabsorbed[3]. This suggests evidence of the monoamine-deficiency theory.

The network hypothesis

Another biology-based model for the rise of depression also comprises problems on a neuronal level and furthers the monoamine deficiency theory[6]. This model revolves around the hypofunction of activity-required communication between neurons: the network hypothesis[6]. Leistedt et al describe that 'a key aspect of this view is the recognition that the principal role of the nervous system is not to handle chemicals [, which are responsible for cell communication,] but to store and process information'[6 (p 57)]. Thus, one has to distinguish clearly between the function of chemicals and neurons. Neurotransmitters and other chemicals are essential for synaptic signals, whereas neurons work as the hard drive, utilizing an elaborated inter-cooperation[6]. Since these elements of the body are in control of producing these and all other materials, this theory describes the consequences of low monoamine levels, which underlines again how various factors are responsible for depression and other mental disorders which are based on the dysfunction of the body's most fundamental systems[6].

What causes decreased levels of monoamines, which lead to anatomical shifts in the brain and cause a dysfunction in neuronal communication?

Stress is a great risk factor for an affliction of depression[1]. It is perceived differently by every individual, depending on one's personality[1].

Furthermore, psychosocial factors, such as childhood trauma, chronic physical pain and other traumatic life events can lead to depression[6,10,11].

All of the above factors would increase stress enormously and the hypothalamic-pituitary-adrenal axis (HPA) increases the release of the stress hormone cortisol[8,12]. Studies have shown increased hypercortisolism in patients with depression[9]. If this happens in an early stage (childhood trauma), the correct development of the hippocampus is hampered[6].

If the HPA axis releases too much cortisol, the production of monoamines decreases, triggering eventual apoptosis of neurons[8].

The coherence between psychological or social stress, respectively, and its biological response to the body proves the interconnectedness of the biopsychosocial model (Figure 1).

In 1979, the psychiatrist Aaron Beck further advanced his cognitive theory of depression, describing how thinking errors lead to a catastrophic view of life[1,13]. His key aetiological concept constitutes an abnormally negative way of thinking due to attitude and experiences, which sparks the biological causes for depression[13]. Eventually, his causal model became the basis of the cognitive behavioural therapy[1].

Treatment of Depression

Rebecca presents certain biological and cognitive symptoms for depression, suffering from a long-lasting depressive mood throughout the day, loss of social involvement and sleep disturbances[1,10]. They result in Rebecca's inability to properly concentrate, her guilty feelings, and her lack of energy[1,4]. If these typical symptoms last for at least two weeks, a diagnosis of Major Depressive

Disorder (MDD) is indicated[8]. Rebecca's expectations of herself are very high. Inability to fulfil these expectations increasingly draws her into this vicious cycle of depression. Considering that Rebecca is a second year medical student, she faces the perhaps most stressful time of her life so far, which, in Rebecca's case, is the main factor of her MDD[14].

Given that Rebecca has already faced two months of depressive symptoms, action has to be taken[8]. Luckily, there are different approaches to improve Rebecca's mental illness, which often work in a symbiosis of psychosocial and pharmacological treatment[4]. Later stages of an untreated MDD could eventually lead to thoughts and attempts of suicide[10].

Pharmacological Treatment

Treatment with antidepressants can enhance the problematically functioning propagation of information in the monoamine-deficiency afflicted areas[6]. There are two main types of antidepressant drugs: monoamine uptake inhibitors, which include tricyclic antidepressants (TCAs) as well as selective serotonin reuptake inhibitors (SSRIs), and monoamine oxidase inhibitors (MAOIs)[15]. Despite their different chemical structures and functions, all of them take action in the synaptic cleft and thus improve monoamine transmission (Figure 2)[15].

The monoamine reuptake inhibitors block the reuptake of serotonin and/or noradrenaline from the synaptic cleft back into the presynaptic nerve terminal[15]. Hence, the neurotransmitters stay in the synaptic cleft and are more likely to bind to the postsynaptic receptor sites[16]. Thus, the signal is transmitted in the same manner as it has arrived[15]. Tricyclic antidepressants (like imipramine or amitriptyline) are the earliest versions of antidepressants and inhibit 5-HT and NA reuptake, whereas SSRIs (for example fluoxetine or paroxetine) are selective for blocking the reuptake of serotonin[15,16]. SSRIs and TCAs also have similar efficacy, however, TCAs have a higher risk of overdose, resulting in confusion, mania and irregularity of heartbeat[15]. Furthermore, the older TCAs have more severe adverse effects like sedation, postural hypotension and blurred vision, whereas the intake of SSRIs could cause nausea, insomnia and loss of libido[15].

Surprisingly, scientists have explored that if the longer, normally functioning alleles of 5-HTTLPR exist in a homozygous characteristic (and thus 5-HTT gets produced efficiently), it has a positive effect on SSRI efficacy, even though or maybe precisely because 5-HTT and SSRIs have directly opposing functions[3,15,17].

The other kind of antidepressants, monoamine oxidase inhibitors (like phenelzine or tranylcypromine) decrease the actions of monoamine oxidase, causing an irreversible damage of these enzymes, which break down monoamines in the presynaptic axon terminal[15,16]. Thus, more monoamines stay available for release into the synaptic cleft[16]. Nowadays, MOAIs are rarely used for a primary pharmacological treatment of MDD due to a relatively low efficacy and the substantial side effects they carry along[15]. They are now only prescribed if no other antidepressant drug shows a positive patient response[15].

Fortunately, recent findings prove that antidepressants can physically restore hippocampal volume by the production of new neurons[3,15]. Despite the fact that SSRI and MAOI antidepressants create an instant response by the increase of monoamine transmission, it takes at least a few weeks for them to show an improvement of the patient's symptoms due to resulting adaptions in the body[6,15].

Psychosocial treatment

According to the biopsychosocial model, it is crucial to not only restore one's biological equilibrium – potentially with antidepressants-, but also to target the psychosocial factors that triggered the outburst of depression[7].

Depending on the severity of the patient's depression, psychotherapy alone or in combination with antidepressants may be appropriate, as it is evident that psychotherapy improves depressive state[10,18]. Its application has demonstrated changes in the activation of cerebral areas related to depression similar to areas observed with antidepressants[7].

A well-known psychological therapy for treating depression is the cognitive behavioural therapy (CBT), which was also developed by Beck et al in 1979[18]. In said therapy, patients learn how to recognize and deal with negative emotions and thoughts, as well as coping with them in future[19]. This will change the patient's behaviour and attitude towards stressful events in the long term[19].

While CBT portrays a rather intense therapy, CCBT (computerised behaviour cognitive therapy) represents a great option for a less intensive treatment of this model if needed, which can be accessed online[18].

Furthermore, guided self-help – a form of psychosocial management – will help the depressed individual to acquire the ability to be aware of one's own mental health[19]. If needed, a professional therapist can facilitate this[19]. It displays an effective treatment for moderate depressions and will last approximately six to eight weeks[19].

Additionally, physical exercise provides a perfect way to help regain mental health again, and furthermore maintain it[19]. Ideally, it could be performed in a group of people to establish stable social connections and consistent commitment for training.

Conclusion

To conclude, depression is such a complex disorder because it acts on various levels in the human body and mind. Its causes are still to be further investigated and confirmed, and vary for every patient concerned.

Rebecca's case teaches us how depression must be taken extremely seriously and can happen to anyone. Significant negative changes in behaviour and attitude characterise this mental disease, which should not be underestimated by outsiders. Ultimately, the cause of Rebecca's mental disorder is hard to pinpoint, but stress definitely implies a foundational factor. Fortunately, there is a manifold of treatment for Rebecca, including antidepressants and psychotherapy. Due to the various different origins of depression, one has to approach various strategies targeting both physical and psychological blind spots in order to treat this mental disease successfully.

The cause of Rebecca's condition cannot be clearly stated, as many factors are contributing to it. However, enormous stress resulting in a monoamine deficiency seems to be one logical explanation.

Rebecca's MDD, lasting for two months, needs treatment on a pharmacological basis with SSRIs, because they provide the best combination of high efficacy and minimal adverse effects. In combination with a CCBT and guided-self-help, Rebecca should be able to recover eventually from her condition due to her original cheerful and outgoing nature. However, I would highly recommend getting involved in a sport society, since they provide an excellent compensation to intense study, which is needed as a medical student. Furthermore, relationships to peers, flat mates and other friends are curial to uphold as always challenging situation can and will arise, which can be overcome as a team.

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Figure 1

This Venn diagram illuminates the biopsychosocial model and its overlapping components of biological, social and psychological factors that all contribute to an individual's health[1].

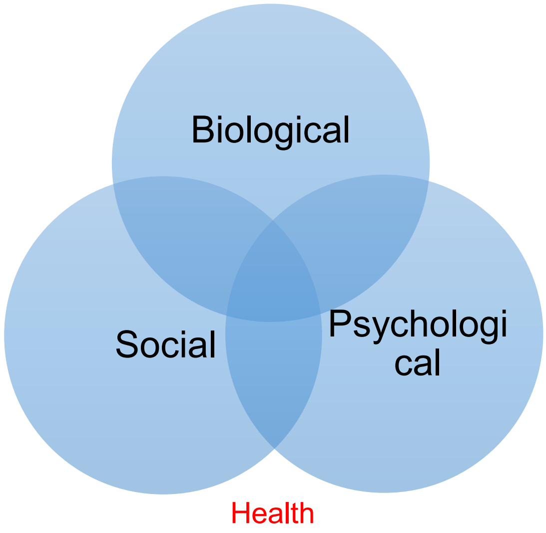
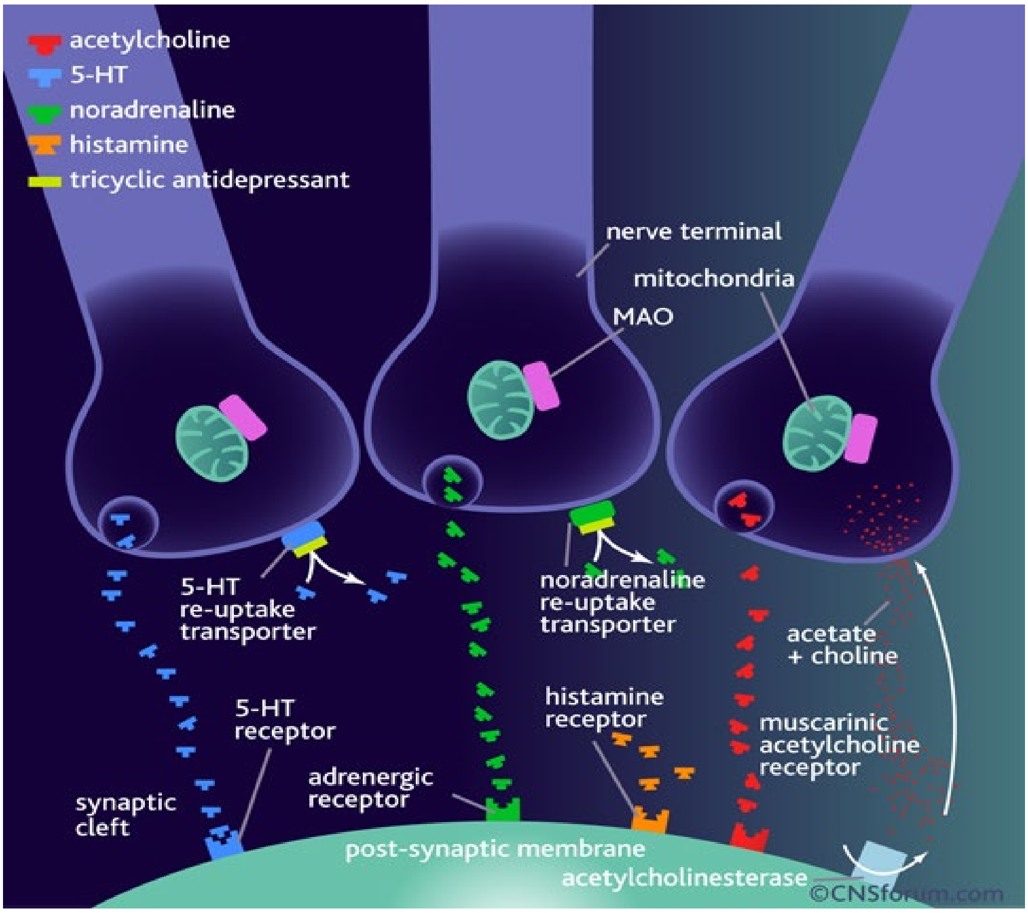


Figure 2

This image reveals monoamine transmission and the mode of action of antidepressants at the synapse[20].



Appendix V Vocabulary Profile Analysis

Freq. Level	Families (%)	Types (%)	Tokens (%)	Cumul. token %
K-1 Words :	291 (51.50)	380 (51.77)	1189 (65.29)	65.29
K-2 Words :	118 (20.88)	148 (20.16)	287 (15.76)	81.05
K-3 Words :	30 (5.31)	36 (4.90)	55 (3.02)	84.07
K-4 Words :	34 (6.02)	36 (4.90)	38 (2.09)	86.16
K-5 Words :	22 (3.89)	26 (3.54)	52 (2.86)	89.02
K-6 Words :	13 (2.30)	13 (1.77)	15 (0.82)	89.84
K-7 Words :	9 (1.59)	10 (1.36)	11 (0.60)	90.44
K-8 Words :	6 (1.06)	7 (0.95)	8 (0.44)	90.88
K-9 Words :	8 (1.42)	8 (1.09)	15 (0.82)	91.7
K-10 Words :	5 (0.88)	5 (0.68)	5 (0.27)	91.97
K-11 Words :	6 (1.06)	7 (0.95)	17 (0.93)	92.9

K-12 Words:	5 (0.88)	5 (0.68)	12 (0.66)	93.56
K-13 Words:	3 (0.53)	3 (0.41)	9 (0.49)	94.05
K-14 Words:	5 (0.88)	6 (0.82)	16 (0.88)	94.93
K-15 Words:	1 (0.18)	1 (0.14)	1 (0.05)	94.98
K-16 Words:				
K-17 Words:	3 (0.53)	3 (0.41)	3 (0.16)	95.14
K-18 Words:	1 (0.18)	1 (0.14)	2 (0.11)	95.25
K-19 Words:	4 (0.71)	4 (0.54)	4 (0.22)	95.47
K-20 Words:	1 (0.18)	1 (0.14)	2 (0.11)	95.58
Off-List:	*??*	*33 (4.50)*	*80 (4.39)*	*99.97*
Total (unrounded)	*565+?*	*734 (100)*	*1821 (100)*	*≈100.00*

Pertaining to whole text	
Words in text (tokens):	1821
Different words (types):	734
Type-token ratio:	0.4
Tokens per type:	2.48
Pertaining to onlist only	
Tokens:	1741
Types:	701
Families:	565
Tokens per Family :	3.08
Types per Family :	1.24

Freq. Level	Families	Families %	Types	Types %	Tokens	Tokens %	Cumul. token %		
K-1 Words	291	51.5	380	51.77	1189	65.29	65.29		
K-2 Words	118	20.88	148	20.16	287	15.76	81.05	**General English Vocabulary**	
K-3 Words	30	5.31	36	4.9	55	3.02	84.07	**342**	**84.07**
K-4 Words	34	6.02	36	4.9	38	2.09	86.16		
K-5 Words	22	3.89	26	3.54	52	2.86	89.02		
K-6 Words	13	2.3	13	1.77	15	0.82	89.84		
K-7 Words	9	1.59	10	1.36	11	0.6	90.44		
K-8 Words	6	1.06	7	0.95	8	0.44	90.88		
K-9 Words	8	1.42	8	1.09	15	0.82	91.7		
K-10 Words	5	0.88	5	0.68	5	0.27	91.97		
K-11 Words	6	1.06	7	0.95	17	0.93	92.9		
K-12 Words	5	0.88	5	0.68	12	0.66	93.56		

*Pertaining to cognates in *classified* on-list items only (Eng 1-11k; Fr 1-5k)*		
Tokens in analysis:		1659
Cognate with French (or with Eng if L=Fr):		538
Non-Cognate with French (or with Eng if L=Fr):		1121
Cognateness:	(538/1659=)	0.32

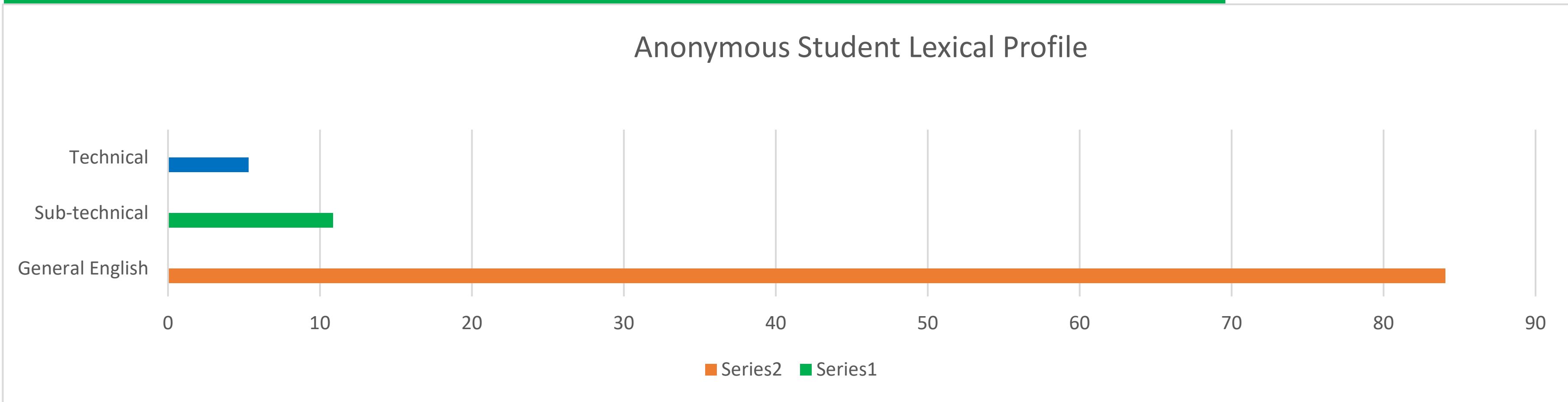
COUNT INDEX

K-13 Words	3	0.53	3	0.41	9	0.49	94.05	Sub-technical Vocabulary	
K-14 Words	5	0.88	6	0.82	16	0.88	94.93	**198**	**10.86**
K-15 Words	1	0.18	1	0.14	1	0.05	94.98		
K-16 Words :	0	0	0	0	0	0	0		
K-17 Words :	3	0.53	3	0.41	3	0.16	95.14		
K-18 Words :	1	0.18	1	0.14	2	0.11	95.25		
K-19 Words :	4	0.71	4	0.54	4	0.22	95.47		
K-20 Words	1	0.18	1	0.14	2	0.11	95.58	Technical Vocabulary	
Off-List:	0	0	33	4.5	80	4.39	99.97	**92**	**5.04**
Total unrounded	0	565	734	100	1821	100	≈100.00		

Sum of individual freqs:	5,122,653,129.00
Divided by rateable tokens	1779
Mean frequency:	2,879,512.72 (SD=6,543,025.03)
Count Index Log(10):	6.46 (SD=15.69)
smaller index = higher proportion low freq items	
Mean frequency:	2,133,002.03 (SD=5,384,583.96)
Count Index Log(10):	6.33 (SD=15.50)
smaller index = higher proportion low freq items	
Mean frequency:	2,133,002.03 (SD=5,384,583.96)
Count Index Log(10):	6.33 (SD=15.50)
smaller index = higher	

Lexical Profile Summative

General English	Sub-technical	Technical	tokens	General English	Sub-technical	Technical
84.07	10.86	5.04		84.07	10.86	5.29



Appendix W Sample of Running Words Identification

Amothericin Example

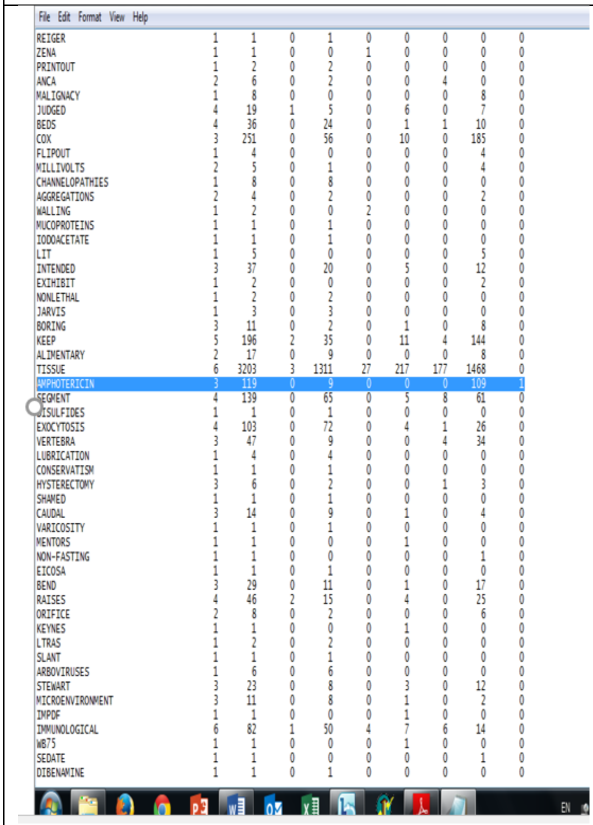


Figure 4 An Example of the Corpus Output Upon Comparing the n. 80 Sub-lists into the Corpus Analysis System.

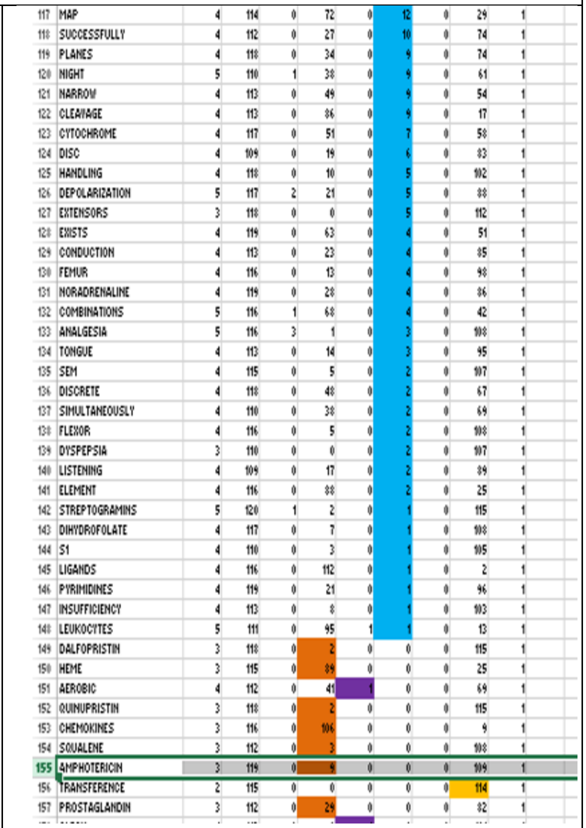


Figure 5 The Main Sources for the Word "amothericin" as They Appear from the RANGE Output.

Appendix X The RecRec Pre-task

ID n._________________ **Age:**________ **Gender:** Male Female

Southampton

Your native language(s) ____
Other language(s) you speak:____
Your highest qualification in English (if it's not your native language):___________________________

Circle the programme you are registered on:

BM6
BM5
BM (EU)
Repeating year 1

Have you taken any of the following exams? (please circle):			
A Levels:	**Abitur**	**A BA degree**	**Other**
Chemistry	Chemistry	(specify subject)	**Qualification(s)**
Biology	Biology	____________	___________

Please tick if you have studied either of the following classical languages:
☐ Latin
☐ Greek

Tick (☑) next to the word(s) that you know.

atpase		exon		influenza		glycorchromia		cytognostic	
arthritis		warfarin		vancomycin		ticarcillin		emphysema	
reagents		corticosteroids		stem		cilia		dermatome	
diuretics		solute		abnormalities		metronidazole		endocytosis	
anaphilia		inhibitory		lactams		lactomiologic		atelectasis	
basodies		substrict		glyoxylate		oocyte		aeruginosa	
antimicrobial		hydrophobic		equilibrium		spectrum		peptide	
golgi		afferent		fibrotraumatic		piperacillin		phosphorylated	
otitis		strands		angina		mosmol		catalase	
pathogenic		endoplasmic		nutridence		aetiology		clostridium	
hepatitine		encephalopathy		synaptic		electron		conundrum	
haematoxylin		procystic		atlas		globerium		staphaureus	
residues		codeine		aneurysms		acetaldehyde		attrition	
codon		dynethics		sacral		emphiminate		vials	
infectides		carboxichemicals		buccal		amoxicillin		doxycycline	
topical		cornea		analgesic		oestrogenomic		physioincision	
medial		haematopoietic		apoptosis		melanomas		teleczema	
antiblasts		pulmonary		antenatal		histamines		fluctuating	
antifungal		carbendectomy		cefuroxime		cutaneous		amnesiac	
flexion		melatonin		alveoli		arteriosclerosis		amoxiclav	
clot		genomic		diastolic		splinter		saccular	
atoms		atrophic		obesity		meiosis		optisitric	
posterior		thalamic		constrict		sulphonamides		neuphron	
homeostasis		teicoplanin		bilirubin		transvalves		stenosis	
phenotype		ions		nuclei		dendrites		micrograph	
dysfunction		endometrial		trisomy		bradypnoea		moxifloxacin	
mucosal		aconiate		catheters		pyrimidines		epithelioid	
deficiency		anaesthetic		induced		rubella		tricepsylase	
substrates		amorphous		gonadotropin		capsulated		sphingomyelin	
pharmacokinetics		peptoglycan		pulmones		epidermal		cathepsin	
allele		controlent		salicylic		hybridizine		basophilic	
bactericidal		cochrane		gonorrhydia		affinity		anxiolytic	
histocode		bacteraemias		hepatomegaly		significant		vesicles	
enterica		colitis		mechanodesmiotic		morphylates		splachnic	
bile		transcreased		lipophilic		microvilli		sarcomere	
anteriolateral		arctire		cardioxide		basis		vecuronium	
swelling		stomen		streptococci		peptidoglycan		intake	
mechanoneuroses		intestinal		polyrectent		cholangitis		neurons	
rinse		karyorrhexis		acidesium		rates		inhibit	
hypoxia		hemothermia		ribonthetic		allantoic		glocrease	

*Please provide an email if you are willing to take part in a 10 mins interview:___________________

Thank you for your participation!

Appendix Y The RecRec post-task

ID n._________________ **Age:**_________ **Gender:** Male Female

UNIVERSITY OF Southampton

Are you an ex-BM6 student who is now in the BM5 program? (circle) Yes No

Tick (☑) next to the word(s) that you know (the first item is provided as an example only).

atpase		exon		influenza		glycorchromia		cytognostic	
arthritis		warfarin		vancomycin		ticarcillin		emphysema	
reagents		corticosteroids		stem		cilia		dermatome	
diuretics		solute		abnormalities		metronidazole		endocytosis	
anaphilia		inhibitory		lactams		lactomiologic		atelectasis	
basodies		substrict		glyoxylate		oocyte		aeruginosa	
antimicrobial		hydrophobic		equilibrium		spectrum		peptide	
golgi		afferent		fibrotraumatic		piperacillin		phosphorylated	
otitis		strands		angina		mosmol		catalase	
pathogenic		endoplasmic		nutridence		aetiology		clostridium	
hepatitine		encephalopathy		synaptic		electron		conundrum	
haematoxylin		procystic		atlas		globerium		staphaureus	
residues		codeine		aneurysms		acetaldehyde		attrition	
codon		dynethics		sacral		emphiminate		vials	
infectides		carboxichemicals		buccal		amoxicillin		doxycycline	
topical		cornea		analgesic		oestrogenomic		physioincision	
medial		haematopoietic		apoptosis		melanomas		teleczema	
antiblasts		pulmonary		antenatal		histamines		fluctuating	
antifungal		carbendectomy		cefuroxime		cutaneous		amnesiac	
flexion		melatonin		alveoli		arteriosclerosis		amoxiclav	
clot		genomic		diastolic		splinter		saccular	
atoms		atrophic		obesity		meiosis		optisitric	
posterior		thalamic		constrict		sulphonamides		neuphron	
homeostasis		teicoplanin		bilirubin		transvalves		stenosis	
phenotype		ions		nuclei		dendrites		micrograph	
dysfunction		endometrial		trisomy		bradypnoea		moxifloxacin	
mucosal		aconiate		catheters		pyrimidines		epithelioid	
deficiency		anaesthetic		induced		rubella		tricepsylase	
substrates		amorphous		gonadotropin		capsulated		sphingomyelin	
pharmacokinetics		peptoglycan		pulmones		epidermal		cathepsin	
allele		controlent		salicylic		hybridizine		basophilic	
bactericidal		cochrane		gonorrhydia		affinity		anxiolytic	
histocode		bacteraemias		hepatomegaly		significant		vesicles	
enterica		colitis		mechanodesmiotic		morphylates		splachnic	
bile		transcreased		lipophilic		microvilli		sarcomere	
anteriolateral		arctire		cardioxide		basis		vecuronium	
swelling		stomen		streptococci		peptidoglycan		intake	
mechanoneuroses		intestinal		polyrectent		cholangitis		neurons	
rinse		karyorrhexis		acidesium		rates		inhibit	
hypoxia		hemothermia		ribonthetic		allantoic		glocrease	

Please circle the answer that best describes you:

- How important is it to pay attention to the medical vocabulary you use in academic essays?

1.Not important at all	2.A little important	3.Somehow important	4.Very important	5.Absolutely important

- Which area was most challenging for you?

1.Learning new medical vocabulary when reading/listening to lectures	2.Using the new medical vocabulary in written essays	3.Both	4.Other________________ _______________________

Rate from 1 (=too much relied) – 7 (= poorly relied) the following resources depending on how much you relied on them for your learning of medical vocabulary during sem. 1.

- ☐ Medical dictionary
- ☐ Medical textbooks
- ☐ Lecture slides
- ☐ Pips
- ☐ SCLAPEL
- ☐ Internet websites (please provide an example):______________________________________
- ☐ Other (please mention): ____

Thank you for your participation!

Appendix Z The RecRec Task Vocabulary List

List of technical, sub-technical vocabulary and imaginary words per band of lexical coverage represented in the RecRec Task			
	TECHNICAL (T)	**SUBTECHNICAL (S)**	**IMAGINARY WORDS (IW)**
Band 1	POSTERIOR	STEM	ACIDESIUM
	PULMONARY	ATOMS	ANAPHILIA
	NEURONS	RATES	ANTIBLASTS
	APOPTOSIS	SIGNIFICANT	ARCTIRE
	INFLUENZA	ABNORMALITIES	BASODIES
	IONS	ANGINA	CARBENDECTOMY
	PEPTIDE	ELECTRON	CARBOXICHEMICALS
	VESICLES	SPECTRUM	CARDIOXIDE
	INHIBIT	OBESITY	CONTROLENT
	INTAKE	BASIS	CYTOGNOSTIC
			DYNETHICS
Band 2	ENDOPLASMIC	NUCLEI	EMPHIMINATE
	GOLGI	AFFINITY	FIBROTRAUMATIC
	INDUCED	ARTHRITIS	GLOBERIUM
	RESIDUES	SWELLING	GLYCORCHROMIA
	RINSE	DEFICIENCY	GLOCREASE
	WARFARIN	DYSFUNCTION	GONORRHYDIA
	VANCOMYCIN	MEDIAL	HEMOTHERMIA
	INTESTINAL	MICROGRAPH	HEPATITINE
	METRONIDAZOLE	ANAESTHETIC	HISTOCODE
	AMOXICILLIN	ANTIMICROBIAL	HYBRIDIZINE
			INFECTIDES
Band 3	PEPTOGLYCAN	ALVEOLI	LACTOMIOLOGIC

	SYNAPTIC	BACTERAEMIAS	MECHANONEUROSES
	HYDROPHOBIC	ANTIFUNGAL	MECHANODESMIOTIC
	LIPOPHILIC	BUCCAL	MORPHYLATES
	GLYOXYLATE	ANTERIOLATERAL	NUTRIDENCE
	DENDRITES	ANXIOLYTIC	OESTROGENOMIC
	STENOSIS	CATHEPSIN	OPTISITRIC
	THALAMIC	ARTERIOSCLEROSIS	PHYSIOINCISION
	ENTERICA	BRADYPNOEA	POLYRECTENT
	GONADOTROPIN	CAPSULATED	PROCYSTIC
			PULMONES
Band 4	MEIOSIS	EQUILIBRIUM	RIBONTHETIC
	ATPASE	ENDOCYTOSIS	STOMEN
	CUTANEOUS	CILIA	SUBSTRICT
	VECURONIUM	LACTAMS	TELECZEMA
	MICROVILLI	AFFERENT	TRANSCREASED
	PIPERACILLIN	CORTICOSTEROIDS	TRANSVALVES
	TEICOPLANIN	FLEXION	TRICEPSYLASE
	DOXYCYCLINE	BACTERICIDAL	**GRAND TOTAL**
	CEFUROXIME	REAGENTS	
	EMPHYSEMA	DIURETICS	
Band 5	SULPHONAMIDES	OTITIS	
	EPIDERMAL	PHARMACOKINETICS	
	OOCYTE	SUBSTRATES	
	MUCOSAL	GENOMIC	
	TOPICAL	PEPTIDOGLYCAN	
	SACRAL	BILE	
	TICARCILLIN	CODON	
	PYRIMIDINES	INHIBITORY	

	DIASTOLIC	HOMEOSTASIS
	COLITIS	STRANDS
Band 6	RUBELLA	SOLUTE
	STREPTOCOCCI	ALLELE
	TRISOMY	PATHOGENIC
	EXON	CONSTRICT
	HAEMATOXYLIN	PHENOTYPE
	AETIOLOGY	CLOT
	CODEINE	ENCEPHALOPATHY
	HYPOXIA	CORNEA
	CLOSTRIDIUM	ATLAS
	DERMATOME	PHOSPHORYLATED
Band 7	MOSMOL	CATHETERS
	ACETALDEHYDE	AERUGINOSA
	SALICYLIC	COCHRANE
	HEPATOMEGALY	ANEURYSMS
	SPHINGOMYELIN	CATALASE
	BASOPHILIC	AMORPHOUS
	AMOXICLAV	ENDOMETRIAL
	SARCOMERE	BILIRUBIN
	MELATONIN	HAEMATOPOIETIC
	EPITHELIOID	ATROPHIC
Band 8	SACCULAR	ANTENATAL
	STAPHAUREUS	VIALS
	ATELECTASIS	ANALGESIC
	SPLACHNIC	ATTRITION

	ACONIATE	CONUNDRUM
	ALLANTOIC	HISTAMINES
	NEUPHRON	MELANOMAS
	CHOLANGITIS	AMNESIAC
	MOXIFLOXACIN	FLUCTUATING
	KARYORRHEXIS	SPLINTER
GRAND TOTAL		

Appendix AA Suggestive Version of the Receptive Recognition RecRec Task Tool for Future Research

Information about the RecRec Task

The following information is intended for teachers and/or researchers of EMP students and/or medical students on their first weeks or months of medical studies who consider using the RecRec task tool.

With a view to encourage researchers in the area of EMP to move one step forward from wordlists into conducting investigations on medical students' degree of basic receptive recognition and compare progress over time, a soft copy version of the RecRec is provided in this section. A table of the RecRec is provided along with its' key; the key was designed to assist researchers with entering the data from the print version given that words were randomly ordered in the task. As words in the RecRec are presented without an order in place to get students to look at different words at once together with the IWs, it may be difficult for researchers to locate and tick the right answer during the data entry process. Thus, the RecRec task lexical items were colour coded with blue indicating that they are technical, green indicating that they are sub-technical and with plain red letters signify the Imaginary words. Simplicity is a key feature of the RecRec task aiming to appeal to busy medical students who may be reluctant to spend too much of their time in a research project. Thus, this is a user-friendly vocabulary activity that is only taking an A4 page long and it is has the potential to encourage wider participation.

As discussed in sections 6.4 and 3.6-3.6.8, the present study developed the RecRec as a novel instrument to assess receptive recognition of technical and sub-technical vocabulary appearing in medical students' learning and teaching materials (see section 2.3). Data from the MEDREC corpus of 2,097,627 running words was utilised as the foundation for the generation of the RecRec task. As discussed in sections 3.2-3.2.1, the MEDREC reflects accredited sources that medical students were encouraged by their faculty and medical instructors to utilize for their personal study in order to familiarize themselves with the concepts discussed in the lectures (for an extensive discussion, see section 3.3-3.4.5). The RecRec covers 60%-99% of LETERs vocabulary with 60% indicating *severe learning burden/difficulty with the vocabulary and 99% indicating fluent reading and sufficient vocabulary knowledge. Each percentage (%) of lexical coverage was studied separately. General English vocabulary was eliminated, and corpus comparison was conducted with the BNC headwords. The resulting technical and sub-technical vocabulary items were then grouped into 5% degrees of lexical coverage and their range and frequency was looked at in order to decide their suitability to represent their lexical band (see section 3.6.6) in the RecRec.*

A total of 10 lexical items for each of the 8 lexical bands of technical and sub-technical vocabulary resulted in a total of 80 technical and 80 sub-technical items. To enhance RecRec's reliability and validity, a total of 20 Imaginary Words were designed as discussed in section 3.6.7, which play a significant role in scores' adjustment, as explained in Appendix W. This led to the generation of a total of 200 word items included in the RecRec task, which fit only on one side of an A4 page.

Appendix BB Suggestions for the RecRec Task Administration Process

The following information is intended for researchers who wish to utilize the RecRec task for research purposes.

- *You may delete the grey part of the A4 page (see Appendix CC) and replace it with demographic information or mini questionnaire depending on the project's scope.*
- *The RecRec task is intended for both EMP students and medical students who acquire their medical information in the English medium.*
- *Students may or may not be informed of the existence of Imaginary words included in it, this will depend on the project.*
- *Students should not use any form of dictionary or the internet at the time of the task.*
- *No time limit should be given to students to avoid distraction.*
- *The RecRec task is suitable for both L1 English and L2 English participants.*

Appendix CC The RecRec Task

Tick (☑) next to the word(s) that you know

atpase		exon		influenza		glycorchromia		cytognostic	
arthritis		warfarin		vancomycin		ticarcillin		emphysema	
reagents		corticosteroids		stem		cilia		dermatome	
diuretics		solute		abnormalities		metronidazole		endocytosis	
anaphilia		inhibitory		lactams		lactomiologic		atelectasis	
basodies		substrict		glyoxylate		oocyte		aeruginosa	
antimicrobial		hydrophobic		equilibrium		spectrum		peptide	
golgi		afferent		fibrotraumatic		piperacillin		phosphorylated	
otitis		strands		angina		mosmol		catalase	
pathogenic		endoplasmic		nutridence		aetiology		clostridium	
hepatitine		encephalopathy		synaptic		electron		conundrum	
haematoxylin		procystic		atlas		globerium		staphaureus	
residues		codeine		aneurysms		acetaldehyde		attrition	
codon		dynethics		sacral		emphiminate		vials	
infectides		carboxichemicals		buccal		amoxicillin		doxycycline	
topical		cornea		analgesic		oestrogenomic		physioincision	
medial		haematopoietic		apoptosis		melanomas		teleczema	
antiblasts		pulmonary		antenatal		histamines		fluctuating	
antifungal		carbendectomy		cefuroxime		cutaneous		amnesiac	
flexion		melatonin		alveoli		arteriosclerosis		amoxiclav	
clot		genomic		diastolic		splinter		saccular	
atoms		atrophic		obesity		meiosis		optisitric	
posterior		thalamic		constrict		sulphonamides		neuphron	
homeostasis		teicoplanin		bilirubin		transvalves		stenosis	
phenotype		ions		nuclei		dendrites		micrograph	
dysfunction		endometrial		trisomy		bradypnoea		moxifloxacin	
mucosal		aconiate		catheters		pyrimidines		epithelioid	
deficiency		anaesthetic		induced		rubella		tricepsylase	
substrates		amorphous		gonadotropin		capsulated		sphingomyelin	
pharmacokinetics		peptoglycan		pulmones		epidermal		cathepsin	
allele		controlent		salicylic		hybridizine		basophilic	
bactericidal		cochrane		gonorrhydia		affinity		anxiolytic	
histocode		bacteraemias		hepatomegaly		significant		vesicles	
enterica		colitis		mechanodesmiotic		morphylates		splachnic	
bile		transcreased		lipophilic		microvilli		sarcomere	
anteriolateral		arctire		cardioxide		basis		vecuronium	
swelling		stomen		streptococci		peptidoglycan		intake	
mechanoneuroses		intestinal		polyrectent		cholangitis		neurons	
rinse		karyorrhexis		acidesium		rates		inhibit	
hypoxia		hemothermia		ribonthetic		allantoic		glocrease	

Appendix DD The RecRec Task Key and Suggestions

- *The RecRec Key has been designed with a view to help the researcher follow the answers provided on the RecRec and document them as appropriate during data entry.*
- *The tick boxes include a code of one letter and one number:*
  T: *stands for Technical vocabulary item*
  S: *for sub-technical vocabulary item and each number next to a letter represents a band. For instance, T4 represents technical vocabulary that belongs to Band 4 (75%-79% of lexical coverage), as discussed in section 3.6.6.*
- **IW**: *stands for imaginary word*
- *In addition, the RecRec key is colour coded to facilitate study with blue representing technical vocabulary, green representing sub-technical vocabulary and red representing imaginary words as seen on the RecRec Key table.*
  Imaginary words can be calculated by means of utilizing the scores adjustment formula discussed in Appendix W.

Atpase	T4	exon	T6	influenza	T1	glycorchromia	IW	cytognostic	IW
Arthritis	S2	warfarin	T2	vancomycin	T2	ticarcillin	T5	emphysema	T4
reagents	S4	corticosteroids	S4	stem	S1	cilia	S4	dermatome	T6
diuretics	S4	solute	S6	abnormalities	S1	metronidazole	T2	endocytosis	S4
anaphilia	IW	inhibitory	S5	lactams	S4	lactomiologic	IW	atelectasis	T8
basodies	IW	substrict	IW	glyoxylate	T3	oocyte	T5	aeruginosa	S7
antimicrobial	S2	hydrophobic	T3	equilibrium	S4	spectrum	S1	Peptide	T1
golgi	T2	afferent	S4	fibrotraumatic	IW	piperacillin	T4	phosphorylated	S6
otitis	S5	strands	S5	angina	S1	mosmol	T7	catalase	S7
pathogenic	S6	endoplasmic	T2	nutridence	IW	aetiology	T6	clostridium	T6
hepatitine	IW	encephalopathy	S6	synaptic	T3	electron	S1	conundrum	S8
haematoxylin	T6	procystic	IW	atlas	S6	globerium	IW	staphaureus	T8
residues	T2	codeine	T6	aneurysms	S7	acetaldehyde	T7	attrition	S8
codon	S5	dynethics	IW	sacral	T5	emphiminate	IW	vials	S8
infectides	IW	carboxichemicals	IW	buccal	S3	amoxicillin	T2	doxycycline	T4
topical	T5	cornea	S6	analgesic	S8	oestrogenomic	IW	physioincision	IW
medial	S2	haematopoietic	S7	apoptosis	T1	melanomas	S8	teleczema	IW
antiblasts	IW	pulmonary	T1	antenatal	S8`	histamines	S8	fluctuating	S8
antifungal	S3	carbendectomy	IW	cefuroxime	T4	cutaneous	T4	amnesiac	S8
flexion	S4	melatonin	T7	alveoli	S3	arteriosclerosis	S3	amoxiclav	T7
clot	S6	genomic	S5	diastolic	T5	splinter	S8	saccular	T8
atoms	S1	atrophic	S7	obesity	S1	meiosis	T4	optisitric	IW
posterior	T1	thalamic	T3	constrict	S6	sulphonamides	T5	neuphron	T8
homeostasis	S5	teicoplanin	T4	bilirubin	S7	transvalves	IW	stenosis	T3
phenotype	S6	ions	T1	nuclei	S2	dendrites	T3	micrograph	S2
dysfunction	S2	endometrial	S7	trisomy	T6	bradypnoea	S3	moxifloxacin	T8
mucosal	T5	aconiate	T8	catheters	S7	pyrimidines	T5	epithelioid	T7
deficiency	S2	anaesthetic	S2	induced	T2	rubella	T6	tricepsylase	IW
substrates	S5	amorphous	S7	gonadotropin	T3	capsulated	S3	sphingomyelin	T7
pharmacokinetics	S5	peptoglycan	T3	pulmones	IW	epidermal	T5	cathepsin	S3
allele	S6	controlent	IW	salicylic	T7	hybridizine	IW	basophilic	T7
bactericidal	S4	cochrane	S7	gonorrhydia	IW	affinity	S2	anxiolytic	S3
histocode	IW	bacteraemias	S3	hepatomegaly	T7	significant	S1	vesicles	T1
enterica	T3	colitis	T5	mechanodesmiotic	IW	morphylates	IW	splachnic	T8
Bile	S5	transcreased	IW	lipophilic	T3	microvilli	T4	sarcomere	T7
anteriolateral	S3	arctire	IW	cardioxide	IW	basis	S1	vecuronium	T4
Swelling	S2	stomen	IW	streptococci	T6	peptidoglycan	S5	intake	T1
mechanoneuroses	IW	intestinal	T2	polyrectent	IW	cholangitis	T8	neurons	T1
Rinse	T2	karyorrhexis	T8	acidesium	IW	rates	S1	inhibit	T1
Hypoxia	T6	hemothermia	IW	ribonthetic	IW	allantoic	T8	glocrease	IW

Appendix EE Sample of Essays analysis on VocabProfiler

Essay 1

introduction

internationally depression rates are higher in medical students than students of other disciplines a study at university college london showed nearly of students suffer from some form of depression

core symptoms of major depressive disorder are extremely low mood and anhedonia the inability to feel pleasure diagnostic classifications diagnose depression on the presence of these for at least two weeks with the severity of the depression depending on the number of other symptoms present including insomnia hypersomnia psychomotor disturbances fatigue feelings of worthlessness or guilt significant weight loss or gain difficulty concentrating and suicidal thoughts patients suffering from around of these symptoms have mild depression while a patient with severe depression would show most or all of the above as well as decreased social functioning nice advises that the degree of social dysfunction and the length of suffering should also be considered the case history presented suggests that rebecca is suffering from mild moderate depression

causes of depression

many things can contribute towards the development of depression the main theories of which are dis cussed below

biological

monoamine hypothesis the longest standing explanation relates to neurotransmitters in the limbic system of the brain this controls memory and regulates mood during acute stress serotonergic activity increases to remove the stressful stimulus which may be internal or external and restore homeostasis however during chronic stress with which the body is unable to cope there is a reduction in this and other neurotransmitters noradrenaline and dopamine however it has been argued this is too simplistic as when given antidepressants although neurotransmitter concentration increases immediately it is several weeks before the patient experiences an improvement in mood

network hypothesis this theory is built on the idea that the primary function of the brain is to store and process information not to transfer chemicals neuroplasticity in the brain allows information to be stored in complex networks of neurons that are constantly changing due to environmental interactions changes in these interactions disturb efficient information processing causing depression

these two hypotheses are not mutually exclusive but complementary as changes to neuronal activity stimulates a change in neurotransmitter concentrations and changes in concentrations will alter neuroplasticity

learned helplessness

this occurs in those experiencing stressful situations they are unable to control during a stressful event an organism will feel fear this continues until either they overcome the fear event or they realise they are unable to control it at this stage the body shuts down attempting to reduce the fear reducing energy usage and the desire to escape this state is depression

this was revised to suggest that those with negative attributional styles are more likely to suffer from depression a person can describe an outcome as attributes internal external stable unstable and global specific those with negative attributional styles describe a positive outcome as external unstable and specific and negative outcomes as internal stable and global giving them the impression that all is hopeless and positive outcomes are luck they cannot influence it they stop trying which can cause less positive outcomes proving this belief and leading to depression

social complexity and identity

a person personality consists of aspects each being a different part of their life for example sister student swimmer each has different attributes and is placed on a continuum of easygoing conscientious and outgoing reserved figure

social identity relates to how much a person feels accepted by their social group a sense of shared identity increases self esteem and provides support and encouragement however this can also cause an i ndividual to fall in line with social norms this can have a negative effect if unhealthy norms are promoted self complexity and identity can both contribute to and protect against depression they interact to affect each person differently

cognitive

beck suggested that thoughts and behavior are coordinated by schemata these are stable beliefs formed from childhood about oneself and their world past and future they are used to interpret stressful situations produce a response and are reflected in negative automatic thoughts these appear from nowhere but are accepted without questioning and produce the cognitive triad a negative self view a negative view of the world and the feeling of a hopeless future regular negative automatic thoughts result in cognitive errors logical errors in thinking beck identified different types including magnification an event interpreted as more important than reality overgeneralisation arbitrary inference drawing conclusions without relevant evidence and selective abstraction fixating on minor details taken out of context the combination of negative schemata negative automatic thoughts and cognitive errors leads to depression as events are interpreted as a result of their actions

genetics

a study showed that twice as many monozygotic twins show concordance of depression than dizygotic genes affecting neurotransmitter synthesis transmission and breakdown are thought to contribute gen

etics may also influence treatment efficacy
sociocultural
many sociocultural aspects can increase ones risk
of depression including ethnicity unemployment an
d gender women are twice as likely to suffer from d
epression than men a history of child abuse is also
a common precursor to depression
biopsychosocial
depression affects the patient on many levels this
model takes into account the biological disturbance
s psychological stress and social difficulties and th
e interactions between them one theory relating to t
his is the diathesis stress theory it suggests that th
e extent of vulnerability to depression the diathesis
effects the degree of stress needed to bring about d
epression
diathesis genetic factors and childhood experience
s form a cognitive diathesis negative early life expe
riences create strong diatheses meaning smaller str
essful stimuli cause depression those with weak di
atheses are more resistant as larger stresses are re
quired with each depressive episode the diathesis g
ets stronger making the person more likely to suffer
repeated episodes
stress on exposure to stress the hypothalamus sti
mulates cortisol release from the adrenal complex li
miting activation of the hypothalamus pituitary adre
nal hpa axis the amygdala which controls negative
emotions receives emotional stimuli and activates t
he hpa axis this ensures the correct degree of activ

ation in the hpa axis for correct behaviours to remove the stress when this stress is not removed continued exposure to cortisol becomes neurotoxic causing a reduction of cortisol receptors in the hippocampus this reduces cortisol concentration and in turn stops the limiting of the hpa axis this decreases levels of brain derived neurotrophic factor bdnf which regulates neuroplasticity a decrease in bdnf causes a decrease in hippocampal neurogenesis and therefore a loss of dendrites and synapses and a reduction in neuron proliferation survival and function decreased gray matter in the hippocampus limits its ability to regulate stress and generate emotion sustained cortisol release also causes an increase in monoamine oxidase reducing the secretion of serotonin and noradrenaline this lowers the efficiency of information processing in the brain and the ability to process positive feelings and emotions causing the characteristic low mood of depression

treatment options

the doctor should consider the patient personal symptoms and previous treatments to decide the best option nice highlights the importance of receiving fully informed consent before beginning treatment and recommends using the stepped care method to guide intervention choice figure

pharmacological

when choosing an antidepressant the clinician must consider possible side effects and toxicity in over dose especially in patients at risk of suicide hypernatreamia is common with antidepressants and should be monitored throughout treatment antidepressants should not be first choice for mild depression they are recommended in moderate severe depression or chronic sub threshold depressive symptoms and are most effective combined with psychological therapy it is recommended patients continue taking antidepressants for at least months after entering remission years for those with recurrent episodes when stopping there should be a gradual decrease in dosage over weeks to reduce chances of discontinuation symptoms

selective serotonin reuptake inhibitors ssris ssris prevent serotonin reuptake in synapses causing increases in concentration in the brain however there is a response delay of a few weeks after taking the drug supporting the network hypothesis ssris do not affect noradrenaline so have less side effects than other antidepressants although they are just as effective making them first choice in adults they also have a relatively low toxicity in overdose however they can cause increased risk of self harm and suicide attempts in under meaning they are not recommended for rebecca but may still be used with caution due to their efficacy ssris cause discontinuation symptoms usually lasting approximately weeks but are self resolving

serotonin and noradrenaline reuptake inhibitors snris is similar to ssris but cause increases in both serot onin and noradrenaline they cause a greater improvement in episodic and working memory but have more severe side effects and discontinuation symptoms

tricyclics also have a similar method to increase serotonin concentration however this group is more dangerous in overdose and has strong side effects although tolerance to these does develop tricyclics are not used in adolescents as they have low efficacy and high side effect rates

monoamine oxidase inhibitors maois these prevent monoamine oxidase mao action and cause an increase in noradrenaline however they also work on mao in the liver and intestines where normally it breaks down tyramine a protein that prevents fatal increases in blood pressure therefore these are only prescribed by specialists and patients must follow a restricted diet

st john wort a herbal remedy that can have antidepressant effects however clinicians should not recommend or prescribe it as it has many interactions with conventional drugs

psychotherapy

there are many forms of psychotherapy but cognitive behavioural therapy cbt is most widely accepted it includes sessions over months it is goal orientated and involves working with different aspects of thoughts cbt co operates cognitive structures such as childhood memories cognitive processes like probl em solving and cognitive products including beliefs and attributions it starts with education in the connections between these emotions and behaviour and scheduling activities to overcome social withdrawal and add purpose to the patient day developing to include cognitive rehearsal practice overcoming previous difficult experiences and social skills and problem solving training problem solving helps the individual understand there is often more options than they first thought this continues to progress and behavioural hypothesis testing is introduced to challenge and disprove negative assumptions this is monitored by recording daily thoughts and feelings

psychotherapy is often used in collaboration with antidepressants but shows comparable results to antidepressants in stand alone trials with lower relapse rates it would be beneficial to rebecca to help her understand and overcome her self doubt however it is not suitable for severe depression other forms of psychotherapy include interpersonal therapy and behavioural activiation

other treatments

exercise it has been suggested that exercise can help in those with sub threshold or mild depression however studies have been inconclusive however exercise may be advantageous for rebecca as a university sports club will give her a sense of self identity and reduce social withdrawal

ketamine studies have shown that ketamine can improve treatment resistant depression however a ma intenance strategy is needed to prevent relapse

electroconvulsive therapy ect this involves creating controlled epileptic convulsions to reduce depression it can cause cognitive damage so is only used when benefits outweigh the risks for example in those with high suicide risk bilateral high doses cause increased cognitive and memory impairment which can last up to months but have the highest efficacy

psychosurgery in those with very severe treatment resistant depression surgery is available to create lesions in affected parts of the brain however it can cause epilepsy and has high rates of post surgery suicide

conclusion

depression is not fully understood and has many causes and treatments new medications needs to be developed as studies show multiple side effects low remission and high relapse rates researchers are trying to identify genes that affect depression in order to target them in drug therapy however it is difficult to find a perfect cure due to its heterogeneity patients need a treatment plan as personal as themselves and their depression

this is also true in the case of rebecca ssris would not be ideal due to her age but a combination of other antidepressants and psychotherapy would be recommended with exercise included in the scheduled activities of cbt.

Types List [↑]
type_[number of tokens]

BNC-1,000 types: [fams 293 : types 403 : tokens 1373]

a_[42] ability_[2] about_[2] accepted_[3] account_[1] action_[1] actions_[1] activities_[2] activity_[2] add_[1] affect_[3] affected_[1] affecting_[1] affects_[1] after_[2] against_[1] age_[1] all_[2] allows_[1] also_[9] although_[3] an_[8] and_[82] appear_[1] are_[29] argued_[1] around_[1] as_[21] assumptions_[1] at_[5] available_[1] be_[12] becomes_[1] been_[3] before_[2] beginning_[1] being_[1] beneficial_[1] benefits_[1] best_[1] between_[2] blood_[1] body_[2] both_[2] breaks_[1] bring_[1] built_[1] but_[10] by_[4] can_[14] cannot_[1] care_[1] case_[2] cause_[11] causes_[4] causing_[4] chances_[1] change_[1] changes_[3] changing_[1] characteristic_[1] child_[1] childhood_[3] choice_[3] choosing_[1] club_[1] co_[1] college_[1] common_[2] comparable_[1] consider_[2] considered_[1] continue_[1] continued_[1] continues_[2] control_[2] controlled_[1] controls_[2] correct_[2] create_[2] creating_[1] daily_[1] dangerous_[1] day_[1] decide_[1] degree_[3] depending_[1] describe_[2] details_[1] develop_[1] developed_[1] developing_[1] development_[1] different_[4] differently_[1] difficult_[2] difficulties_[1] difficulty_[1] discussed_[1] do_[1] doctor_[1] does_[1] doubt_[1] down_[2] drawing_[1] due_[4] during_[3] each_[4] early_[1] education_[1] effect_[2] effective_[2] effects_[7] either_[1] encouragement_[1] entering_[1] environmental_[1] especially_[1] evidence_[1] example_[2] exercise_[4] experiences_[4] experiencing_[1] explanation_[1] fall_[1] feel_[2] feeling_[1] feelings_[3] feels_[1] few_[1] figure_[2] find_[1] first_[3] follow_[1] for_[10] form_[2] formed_[1] forms_[2] from_[8] fully_[2] function_[2] functioning_[1] future_[2] gets_[1] give_[1] given_[1] giving_[1] greater_[1] group_[2] has_[7] have_[11] help_[2] helplessness_[1] helps_[1] her_[4] high_[5] higher_[1] highest_[1] history_[2] hopeless_[2] how_[1] however_[14] idea_[1] identified_[1] identify_[1] identity_[5] if_[1] important_[1] improve_[1] improvement_[2] in_[51] inability_[1] include_[2] included_[1] includes_[1] including_[4] increase_[4] increased_[2] increases_[6] individual_[2] information_[4] informed_[1] into_[1] introduced_[1] introduction_[1] involves_[2] is_[30] it_[18] its_[2] just_[1] larger_[1] last_[1] lasting_[1] leading_[1] leads_[1] learned_[1] least_[2] less_[2] levels_[2] life_[2] like_[1] likely_[3] limiting_[2] limits_[1] line_[1] london_[1] longest_[1] low_[5] lower_[1] lowers_[1] luck_[1] main_[1] major_[1] making_[2] many_[7] matter_[1] may_[4] meaning_[2] men_[1] months_[3] more_[7] most_[3] much_[1] must_[2] nearly_[1] need_[1] needed_[2] needs_[1] new_[1] nice_[2] normally_[1] not_[11] nowhere_[1] number_[1] of_[55] often_[2] on_[8] one_[1] ones_[1] only_[2] operates_[1] or_[8] order_[1] other_[7] out_[1] over_[2] part_[1] parts_[1] past_[1] perfect_[1] person_[5] personal_[2] placed_[1] plan_[1] positive_[4] possible_[1] post_[1] practice_[1] present_[1] presented_[1] pressure_[1] previous_[2] problem_[3] process_[2] processes_[1] processing_[2] produce_[2] products_[1] protect_[1] provides_[1] purpose_[1] questioning_[1] rates_[5] realise_[1] reality_[1] receives_[1] receiving_[1] recommend_[1] recommended_[4] recommends_[1] recording_[1] reduce_[4] reduces_[1] reducing_[2] reduction_[3] relates_[2] relating_[1] required_[1] researchers_[1] result_[2] results_[1] self_[7] sense_[2] shared_[1] should_[6] show_[3] showed_[2] shown_[1] shows_[1] shuts_[1] side_[6] similar_[2] simplistic_[1] sister_[1] situations_[2] smaller_[1] so_[2] social_[10] some_[1] specialists_[1] specific_[2] st_[1] stage_[1] stand_[1] standing_[1] starts_[1] state_[1] stepped_[1] still_[1] stop_[1] stopping_[1] stops_[1] strategy_[1] strong_[2] stronger_[1] structures_[1] student_[1] students_[3] studies_[3] study_[2] such_[1] suggest_[1] suggested_[2] suggests_[2] suitable_[1] support_[1] supporting_[1] system_[1] taken_[1] takes_[1] taking_[2] testing_[1] than_[6] that_[14] the_[74] their_[6] them_[4] themselves_[1] there_[5] therefore_[2] these_[10] they_[17] things_[1] thinking_[1] this_[24] those_[8] thought_[2] thoughts_[7] throughout_[1] to_[59] too_[1] towards_[1] training_[1] treatment_[7] treatments_[3] true_[1] trying_[2] turn_[1] twice_[2] two_[2] types_[1] unable_[3] under_[1] understand_[2] understood_[1] unemployment_[1] unhealthy_[1] university_[2] until_[1] up_[1] used_[5] using_[1] usually_[1] very_[1] view_[2] was_[1] weeks_[5] weight_[1] well_[1] when_[5] where_[1] which_[7] while_[1] widely_[1] will_[3] with_[21] without_[2] women_[1] work_[1] working_[2] world_[2] would_[4] years_[1]

BNC-2,000 types: [fams 115 : types 148 : tokens 294]

above_[1] abuse_[1] adults_[1] advantageous_[1] advises_[1] alone_[1] alter_[1] antidepressant_[2] antidepressants_[8] aspects_[3] attempting_[1] attempts_[1] automatic_[3] behavior_[1] behaviour_[1] behavioural_[3] behaviours_[1] below_[1] brain_[7] challenge_[1] chemicals_[1] combination_[2] combined_[1] complex_[2] complexity_[2] concentrating_[1] concentration_[4] concentrations_[2] conclusion_[1] conclusions_[1] connections_[1] constantly_[1] context_[1] contribute_[3] cope_[1] damage_[1] delay_[1] depression_[34] depressive_[3] desire_[1] diet_[1] drug_[2] drugs_[1] efficiency_[1] efficient_[1] emotion_[1] emotional_[1] emotions_[3] energy_[1] ensures_[1] escape_[1] event_[3] events_[1] exclusive_[1] extent_[1] extremely_[1] factor_[1] factors_[1] fear_[3] gain_[1] generate_[1] goal_[1] gradual_[1] gray_[1] guide_[1] guilt_[1] harm_[1] highlights_[1] ideal_[1] immediately_[1] impression_[1] influence_[2] internal_[3] internationally_[1] interpret_[1] interpreted_[2] length_[1] logical_[1] loss_[2] maintenance_[1] medical_[1] memories_[1] memory_[3] method_[2] minor_[1] model_[1] monitored_[2] negative_[13] occurs_[1] option_[1] options_[2] patient_[5] patients_[5] pleasure_[1] prevent_[3] prevents_[1] progress_[1] promoted_[1] proving_[1] psychological_[2] reflected_[1] regular_[1] regulate_[1] regulates_[2] relatively_[1] release_[2] relevant_[1] remove_[2] removed_[1] repeated_[1] reserved_[1] resistant_[3] response_[2] restricted_[1] revised_[1] risk_[4] risks_[1] scheduled_[1] scheduling_[1] selective_[2] sessions_[1] several_[1] severe_[5] severity_[1] significant_[1] skills_[1] solving_[3] sports_[1] stable_[3] store_[1] stored_[1] stress_[10] stresses_[1] stressful_[5] styles_[2] sub_[2] suffer_[4] suffering_[3] survival_[1] swimmer_[1] target_[1] theories_[1] theory_[3] transfer_[1] trials_[1] unstable_[2] weak_[1] withdrawal_[2]

BNC-3,000 types: [fams 32 : types 39 : tokens 74]

approximately_[1] belief_[1] beliefs_[2] breakdown_[1] clinician_[1] clinicians_[1] conventional_[1] coordinated_[1] core_[1] cure_[1] disciplines_[1] disturb_[1] disturbances_[2] dosage_[1] doses_[1] errors_[3] exposure_[2] external_[3] fatal_[1] global_[2] mild_[4] mood_[4] multiple_[1] norms_[2] orientated_[1] outcome_[2] outcomes_[3] overcome_[3] overcoming_[1] personality_[1] rehearsal_[1] restore_[1] suicidal_[1] suicide_[4] surgery_[2] symptoms_[8] therapy_[5] transmission_[1] twins_[1]

BNC-4,000 types: [fams 25 : types 27 : tokens 34]

attributes_[2] caution_[1] chronic_[2] complementary_[1] conscientious_[1] consists_[1] esteem_[1] ethnicity_[1] gender_[1] genes_[2] herbal_[1] importance_[1] interact_[1] interactions_[4] intervention_[1] liver_[1] magnification_[1] medications_[1] mutually_[1] network_[2] networks_[1] presence_[1] primary_[1] remedy_[1] resolving_[1] sustained_[1] usage_[1]

BNC-5,000 types: [fams 19 : types 25 : tokens 35]

abstraction_[1] activates_[1] activation_[2] arbitrary_[1] biological_[2] collaboration_[1] consent_[1] decrease_[3] decreased_[2] decreases_[1] derived_[1] diagnose_[1] disorder_[1] episode_[1] episodes_[2] episodic_[1] inference_[1] inhibitors_[3] moderate_[2] outgoing_[1] prescribe_[1] prescribed_[1] stimulates_[2] tolerance_[1] vulnerability_[1]

BNC-6,000 types: [fams 7 : types 9 : tokens 13]

genetic_[1] genetics_[2] outweigh_[1] protein_[1] recurrent_[1] stimuli_[2] stimulus_[1] threshold_[2] toxicity_[2]

BNC-7,000 types: [fams 12 : types 12 : tokens 19]

acute_[1] adolescents_[1] axis_[4] classifications_[1] diagnostic_[1] discontinuation_[3] impairment_[1] inconclusive_[1] intestines_[1] overdose_[3] secretion_[1] synthesis_[1]

BNC-8,000 types: [fams 6 : types 6 : tokens 7]

beck_[2] continuum_[1] epilepsy_[1] fatigue_[1] lesions_[1] organism_[1]

BNC-9,000 types: [fams 5 : types 6 : tokens 13]

bilateral_[1] hypotheses_[1] hypothesis_[4] oneself_[1] proliferation_[1] psychotherapy_[5]

BNC-10,000 types: [fams 3 : types 3 : tokens 5]

epileptic_[1] receptors_[1] relapse_[3]

BNC-11,000 types: [fams 7 : types 9 : tokens 21]

cognitive_[12] heterogeneity_[1] insomnia_[1] interpersonal_[1] neuron_[1] neuronal_[1] neurons_[1] precursor_[1] remission_[2]

BNC-12,000 types: [fams 7 : types 8 : tokens 14]

convulsions_[1] disprove_[1] efficacy_[4] fixating_[1] neurotransmitter_[3] neurotransmitters_[2] pharmacological_[1] pituitary_[1]

BNC-13,000 types: [fams 3 : types 3 : tokens 4]

dysfunction_[1] synapses_[2] triad_[1]

BNC-14,000 types: [fams 5 : types 5 : tokens 12]

concordance_[1] dendrites_[1] oxidase_[3] serotonin_[6] wort_[1]

BNC-15,000 types: [fams : types : tokens]

BNC-16,000 types: [fams 2 : types 2 : tokens 3]

dopamine_[1] hypothalamus_[2]

BNC-17,000 types: [fams 3 : types 3 : tokens 4]

adrenal_[2] homeostasis_[1] limbic_[1]

BNC-18,000 types: [fams 4 : types 4 : tokens 8]

cortisol_[5] dizygotic_[1] electroconvulsive_[1] monozygotic_[1]

BNC-19,000 types: [fams 2 : types 2 : tokens 3]

ketamine_[2] neurotoxic_[1]

BNC-20,000 types: [fams 2 : types 2 : tokens 7]

noradrenaline_[6] psychomotor_[1]

OFFLIST: [?: types 36 : tokens 69]

activiation_[1] amygdala_[1] anhedonia_[1] attributional_[2] attributions_[1] bdnf_[2] biopsychosocial_[1] cbt_[3] diatheses_[2] diathesis_[5] easygoing_[1] ect_[1] hippocampal_[1] hippocampus_[2] hpa_[4] hypernatreamia_[1] hypersomnia_[1] john_[1] mao_[2] maois_[1] monoamine_[4] neurogenesis_[1] neuroplasticity_[3] neurotrophic_[1] overgeneralisation_[1] psychosurgery_[1] rebecca_[5] reuptake_[3] schemata_[2] serotonergic_[1] snris_[1] sociocultural_[2] ssris_[6] tricyclics_[2] tyramine_[1] worthlessness_[1]

Families List [↑]

Family [number of tokens]

BNC-1,000 Families: [fams 293 : types 403 : tokens 1373]

VP-negative: bnc-1

a_[50] able_[6] about_[2] accept_[3] account_[1] act_[2] active_[4] add_[1] affect_[6] after_[2] against_[1] age_[1] all_[2] allow_[1] also_[9] although_[3] and_[82] appear_[1] argue_[1] around_[1] as_[21] assume_[1] at_[5] available_[1] be_[76] become_[1] before_[2] begin_[1] benefit_[2] best_[1] between_[2] blood_[1] body_[2] both_[2] break_[1] bring_[1] build_[1] but_[10] by_[4] can_[15] care_[1] case_[2] cause_[19] chance_[1] change_[5] character_[1] child_[4] choice_[3] choose_[1] club_[1] college_[1] common_[2] company_[1] compare_[1] consider_[3] continue_[4] control_[5] correct_[2] create_[3] danger_[1] day_[2] decide_[1] degree_[3] depend_[1] describe_[2] detail_[1] develop_[4] difference_[5] difficult_[4] discuss_[1] do_[2] doctor_[1] doubt_[1] down_[2] draw_[1] due_[4] during_[3] each_[4] early_[1] educate_[1] effect_[11] either_[1] employ_[1] encourage_[1] enter_[1] environment_[1] especial_[1] evidence_[1] example_[2] exercise_[4] experience_[5] explain_[1] fall_[1] feel_[7] few_[1] figure_[2] find_[1] first_[3] follow_[1] for_[10] form_[5] from_[8] full_[2] function_[3] future_[2] get_[1] give_[3] great_[1] group_[2] have_[18] health_[1] help_[4] high_[7] history_[2] hope_[2] how_[1] however_[14] idea_[1] identify_[7] if_[1] important_[1] improve_[3] in_[51] include_[8] increase_[12] individual_[2] inform_[5] into_[1] introduce_[2] involve_[2] it_[20] just_[1] large_[1] last_[2] lead_[2] learn_[1] less_[4] level_[2] life_[2] like_[1] likely_[3] limit_[3] line_[1] london_[1] long_[1] low_[7] luck_[1] main_[1] major_[1] make_[2] man_[1] many_[7] matter_[1] may_[4] meaning_[2] month_[3] more_[7] most_[3] much_[1] must_[2] near_[1] need_[4] new_[1] nice_[2] no_[1] normal_[1] not_[11] number_[1] of_[55] often_[2] on_[8] one_[2] only_[2] operate_[1] or_[8] order_[1] other_[7] out_[1] over_[2] part_[2] past_[1] perfect_[1] person_[7] place_[1] plan_[1] positive_[4] possible_[1] post_[1] practise_[1] present_[2] pressure_[1] previous_[2] problem_[3] process_[5] produce_[2] product_[1] protect_[1] provide_[1] purpose_[1] question_[1] rate_[5] real_[1] realise_[1] receive_[2] recommend_[6] record_[1] reduce_[10] relation_[3] require_[1] research_[1] result_[3] self_[7] sense_[2] share_[1] she_[4] should_[6] show_[7] shut_[1] side_[6] similar_[2] simple_[1] sister_[1] situate_[2] small_[1] so_[2] social_[10] some_[1] special_[1] specific_[2] stage_[1] stand_[2] start_[1] state_[1] step_[1] still_[1] stop_[3] strategy_[1] street_[1] strong_[3] structure_[1] student_[4] study_[5] such_[1] suggest_[5] suit_[1] support_[2] system_[1] take_[4] test_[1] than_[6] the_[74] there_[5] therefore_[2] they_[28] thing_[1] think_[10] this_[56] through_[1] to_[59] too_[1] toward_[1] train_[1] treat_[10] true_[1] try_[2] turn_[1] two_[4] type_[1] under_[1] understand_[3] university_[2] until_[1] up_[1] use_[6] usual_[1] very_[1] view_[2] week_[5] weigh_[1] well_[1] when_[5] where_[1] which_[7] while_[1] wide_[1] will_[3] with_[21] without_[2] woman_[1] work_[3] world_[2] would_[4] year_[1]

BNC-2,000 Families: [fams 115 : types 148 : tokens 294]

VP-negative: bnc-2

above_[1] abuse_[1] adult_[1] advantage_[1] advise_[1] alone_[1] alter_[1] aspect_[3] attempt_[2] automatic_[3] behaviour_[6] below_[1] brain_[7] challenge_[1] chemical_[1] combine_[3] complex_[4] concentrate_[7] conclusion_[2] connect_[1] constant_[1] context_[1] contribute_[3] cope_[1] damage_[1] delay_[1] depress_[47] desire_[1] diet_[1] drug_[3] efficient_[2] emotion_[5] energy_[1] ensure_[1] escape_[1] event_[4] exclude_[1] extent_[1] extreme_[1] factor_[2] fear_[3] gain_[1] generate_[1] goal_[1] gradual_[1] grey_[1] guide_[1] guilty_[1] harm_[1] highlight_[1] ideal_[1] immediate_[1] impress_[1] influence_[2] internal_[3] international_[1] interpret_[3] length_[1] logic_[1] loss_[2] maintain_[1] medical_[1] memory_[4] method_[2] minor_[1] model_[1] monitor_[2] negative_[13] occur_[1] option_[3] patient_[5] patients_[5] pleasure_[1] prevent_[4] progress_[1] promote_[1] prove_[1] psychology_[2] reflect_[1] regular_[1] regulate_[3] relative_[1] release_[2] relevant_[1] remove_[3] repeat_[1] reserve_[1] resist_[3] response_[2] restrict_[1] revise_[1] risk_[5] schedule_[2] select_[2] session_[1] several_[1] severe_[6] significant_[1] skill_[1] solve_[3] sport_[1] stable_[5] store_[2] stress_[16] style_[2] sub_[2] suffer_[7] survive_[1] swim_[1] target_[1] theory_[4] transfer_[1] trial_[1] weak_[1] withdraw_[2]

BNC-3,000 Families: [fams 32 : types 39 : tokens 74]

VP-negative: bnc-3

approximate_[1] belief_[3] breakdown_[1] clinic_[2] convention_[1] coordinate_[1] core_[1] cure_[1] discipline_[1] disturb_[3] dose_[2] error_[3] expose_[2] external_[3] fatal_[1] global_[2] mild_[4] mood_[4] multiple_[1] norm_[2] orient_[1] outcome_[5] overcome_[4] personality_[1] rehearse_[1] restore_[1] suicide_[5] surgery_[2] symptom_[8] therapy_[5] transmit_[1] twin_[1]

BNC-4,000 Families: [fams 25 : types 27 : tokens 34]

VP-negative: bnc-4

attribute_[2] caution_[1] chronic_[2] complement_[1] conscientious_[1] consist_[1] esteem_[1] ethnic_[1] gender_[1] gene_[2] herb_[1] importance_[1] interact_[5] intervene_[1] liver_[1] magnify_[1] medication_[1] mutual_[1] network_[3] presence_[1] primary_[1] remedy_[1] resolve_[1] sustain_[1] usage_[1]

BNC-5,000 Families: [fams 19 : types 25 : tokens 35]

VP-negative: bnc-5

abstract_[1] activate_[3] arbitrary_[1] biological_[2] collaborate_[1] consent_[1] decrease_[6] derive_[1] diagnose_[1] disorder_[1] episode_[4] infer_[1] inhibit_[3] moderate_[2] outgoing_[1] prescribe_[2] stimulate_[2] tolerance_[1] vulnerable_[1]

BNC-6,000 Families: [fams 7 : types 9 : tokens 13]

VP-negative: bnc-6

genetic_[3] outweigh_[1] protein_[1] recur_[1] stimulus_[3] threshold_[2] toxic_[2]

BNC-7,000 Families: [fams 12 : types 12 : tokens 19]

VP-negative: bnc-7

acute_[1] adolescent_[1] axis_[4] classification_[1] conclusive_[1] diagnostic_[1] discontinue_[3] impair_[1] intestine_[1] overdose_[3] secrete_[1] synthesis_[1]

BNC-8,000 Families: [fams 6 : types 6 : tokens 7]

VP-negative: bnc-8

beck_[2] continuum_[1] epilepsy_[1] fatigue_[1] lesion_[1] organism_[1]

BNC-9,000 Families: [fams 5 : types 6 : tokens 13]

VP-negative: bnc-9

bilateral_[1] hypothesis_[5] oneself_[1] proliferate_[1] psychotherapy_[5]

BNC-10,000 Families: [fams 3 : types 3 : tokens 5]

VP-negative: bnc-10

epileptic_[1] receptor_[1] relapse_[3]

BNC-11,000 Families: [fams 7 : types 9 : tokens 21]

cognitive_[12] heterogeneity_[1] insomnia_[1] interpersonal_[1] neuron_[3] precursor_[1] remission_[2]

BNC-12,000 Families: [fams 7 : types 8 : tokens 14]

convulse_[1] disprove_[1] efficacy_[4] fixate_[1] neurotransmitter_[5] pharmacology_[1] pituitary_[1]

BNC-13,000 Families: [fams 3 : types 3 : tokens 4]

dysfunction_[1] synapse_[2] triad_[1]

BNC-14,000 Families: [fams 5 : types 5 : tokens 12]

concord_[1] dendrite_[1] oxidase_[3] serotonin_[6] wort_[1]

BNC-15,000 Families: [fams : types : tokens]

BNC-16,000 Families: [fams 2 : types 2 : tokens 3]

dopamine_[1] hypothalamus_[2]

BNC-17,000 Families: [fams 3 : types 3 : tokens 4]

adrenal_[2] homeostatic_[1] limbic_[1]

BNC-18,000 Families: [fams 4 : types 4 : tokens 8]

cortisol_[5] dizygotic_[1] electroconvulsion_[1] monozygotic_[1]

BNC-19,000 Families: [fams 2 : types 2 : tokens 3]

ketamine_[2] neurotoxic_[1]

BNC-20,000 Families: [fams 2 : types 2 : tokens 7]

noradrenaline_[6] psychomotor_[1]

OFFLIST: [?: types 36 : tokens 69]

activiation_[1] amygdala_[1] anhedonia_[1] attributional_[2] attributions_[1] bdnf_[2] biopsychosocial_[1] cbt_[3] diatheses_[2] diathesis_[5] easygoing_[1] ect_[1] hippocampal_[1] hippocampus_[2] hpa_[4] hypernatreamia_[1] hypersomnia_[1] john_[1] mao_[2] maois_[1] monoamine_[4] neurogenesis_[1] neuroplasticity_[3] neurotrophic_[1] overgeneralisation_[1] psychosurgery_[1] rebecca_[5] reuptake_[3] schemata_[2] serotonergic_[1] snris_[1] sociocultural_[2] ssris_[6] tricyclics_[2] tyramine_[1] worthlessness_[1]

Essay 2

introduction
depression or major depressive disorder is mental disorder characterised by the persistent feeling of sadness or irritability which affects person wellbeing according to the world health organisation depression could be the second leading cause of worldwide disease affliction by

our aim is to identify the theoretical causes of depression and evaluate the possible treatment options for rebecca medical student with eg undiagnosed depression

diagnosing rebecca
the case study orients around rebecca who has been feeling unusually pessimistic irritable fatigued and restless for the past months rebecca symptoms are in line with eg symptoms of depression which also include loss of interest and difficulty concentrating both of which rebecca demonstrated from her absence in choir practice and her lack of concentration during lectures study by schwenk et al have shown that prevalence of moderate to severe depression amongst medical students is with a higher incidence amongst women than men compared to however this study was conducted at university of michigan and hence may not reflect the situation in rebecca medical school in the due to differences between course structures and cultures

on presentation of rebecca symptoms to the may refer to the diagnostic and statistical manual of mental disorders the edition iv for diagnosis of depression essential criteria are that the symptoms have to be present for two weeks period of time rebecca has surpassed and that the patient must have either depressed mood or experience loss of interest for most of the day nearly every day the severity is then judged on the number of other symptoms rebecca has the other symptoms that apply to rebecca are insomnia fatigue poor concentration and feelings of worthlessness since rebecca has more symptoms than needed for making the diagnosis rebecca is probably suffering from moderate to severe depression

causes of depression
depression has been noted to be result of mixture of biological and psychological factors with certain events in person life inducing episodes of depression

monoamine theory
the monoamine theory is biological theory that suggests depression is caused by decrease in monoaminergical activity

monoamines are central nervous system neurotransmitters that are released from the presynaptic membrane into the synaptic cleft when an action potential reaches the presynaptic terminal the three main monoamines involved with the depression are dopamine serotonin and noradrenaline one of the main causes of low monoaminergical activity is the metabolising action of the enzymes monoamine oxidase and monoamine oxidase deaminates dopamine serotonin and noradrenaline and metabolises dopamine thus resulting in lower levels of monoamines overall this is supported by study that have found that there is higher density of in depressed patients than in healthy patients

the level of serotonin is also affected by serotonin transporters on the presynaptic membrane which are involved in the reuptake of serotonin from the synaptic cleft hence the inhibition of results in an increased level of serotonin available to bind to receptors on the post synaptic membrane

another principle behind the monoamine hypothesis is that adrenergic receptors on the presynaptic membrane become hypersensitive the alpha autoreceptor controls the output of noradrenaline and the alpha heteroreceptors regulates the output of serotonin from the presynaptic terminal via negative feedback system and when activated they signal for reduced release of the neurotransmitters resulting in lower monoaminergical activity

cytokine theory
it has been noted that patients suffering from depression have all the key symptoms of inflammation including an increased level of pro inflammatory cytokines in the peripheral circulatory system cytokines are small proteins that act as chemical messengers between cells they are produced by variety of cells including immune cells such as macrophages in depression macrophages are activated and release an increased amount of cytokines such as interleukin and interleukin these cytokines have important functions in the immune system and inflammatory response has also been associated with dysregulated sleep patterns in depressed patients aside from disturbances in sleep pro inflammatory cytokines have been known to affect eating behaviours mood and concentration these are cardinal symptoms of depression hence the reason that increased levels of pro inflammatory cytokines have been linked to the aetiology of depression

hyperactivity of hypothalamic pituitary adrenaline axis
another possible cause of depression is the hyperactivity of the axis the axis plays key role in the body stress response and involves the hypothalamus anterior pituitary and adrenal gland during stressful events there is an increased release of corticotrophin releasing hormone the main function of is to signal the secretion of adrenocorticotrophic hormone which in turn stimulates the production of cortisol and glucocorticoids cortisol is involved in regulating the axis via negative feedback system

figure by binding to lucocorticoid receptor this action inhibits the secretion of and and further production of cortisol cortisol also has effects on function learning and mood
in normal physiology the binding of will result in the inhibition of stress induced hyperactivity of the however in depressed patients the are no longer functioning properly and the axis becomes dysregulated leading to high levels of cortisol thus causing changes in mood this is supported by experimental data that have found higher levels of cortisol in depressed individuals than in normal individuals however it could be argued that due to the relatively small sample size the study does not have much statistical power

psychological factors
rebecca as medical student will deal with higher levels of stress than the general population stressors in rebecca life can be divided into two groups personal and academic personal stressors are related to events in rebecca personal life such as illnesses and death academic stressors are related to rebecca course from coping with work set by tutors to career specific stressors such as dealing with patients suffering and death in rebecca case it may be that she observed difficult case in clinical setting which she had found hard to cope with other stressors include dissection and witnessing immoral action of other doctors

the above four causes has been found to be associated with each other figure for instance the inflammatory response and the hyperactivity of axis has been linked to the effect of stress on the sympathetic and parasympathetic nervous system this may explain how stressful events in person life may trigger an episode of depression

another association is that cortisol product from the axis has been found to induce an increased expression for the gene of the serotonin transporter which remove serotonin from the synapse similarly il has been observed to activate the serotonin transporter which will result in lower levels of serotonin in the synapse this offers possible explanation as to why treatments that are based on only one theory are not successful in all patients

treatment
due to the variety of causes underlying depression the treatments available to rebecca range from pharmacological to psychosocial pharmacological treatments mainly consist of antidepressant drugs while psychosocial treatment involves structured meeting with a therapist who helps the patient identify possible stressors in their life either individually or as group

pharmacological treatments
selective serotonin reuptake inhibitors

function by inhibiting resulting in an increased level of serotonin in the synaptic cleft and increasing serotonergic activity are considered as the first line treatment for depression as they are less dangerous in overdoses and more tolerated than nausea insomnia and anorexia are amongst the most common side effects in comparison to cause less drowsiness and are not as cardiotoxic

tricyclic antidepressants
are widely used class of antidepressant drugs and function by blocking the reuptake of serotonin and noradrenaline the selectivity to serotonin and noradrenaline differs between each drug with most drugs being more selective to noradrenergic transmission than serotonergic transmission acute overdose of causes excitement mania and ventricular dysrhythmias common side effects include sedation and postural hypotension which occurs due to the blockade of alpha adrenoreceptor due to the possible dangers associated with overdose are not given to highly suicidal depressed patients

monoamine oxidase inhibitor
drugs are the other major class of antidepressants and the least frequently used amongst the three the mode of action for is by inhibiting the monoamine oxidase enzymes which results in fewer uptakes of monoamines from the synaptic cleft and an increased level for monoaminergic transmission is often considered as an option if treatment with the other classes has been unsuccessful as they can cause sudden changes in blood pressure other side effects include weight gain tremors and insomnia the latter two arise from disproportionate central nervous system stimulation

the effects of the antidepressant drugs are immediate on the targets however it may take one to two weeks for the symptoms to improve the efficacies between the drugs are similar but the side effects vary among them clinician should choose drugs depending on which drug and side effects their patient can effectively manage

psychosocial treatments
cognitive behavioural therapy
is type of psychotherapy which focuses on patient thoughts about themselves and the world and on how their actions can affect their thoughts and behaviour the aim is to change negative behaviour and thoughts to make the patient feel better has been found to be effective in the treatment of mild to moderate depression and is considered the first line treatment for mild depression the main limitation of this type of therapy is that it requires the patient co operation for the therapy to be successful

interpersonal psychotherapy

is based on the principle that psychological symptoms often follow after changes in person interpersonal environment such as the death of loved one the therapist helps the patient identify the relationships that are related to depression as well as focus on the effect of depression on their relationships the therapy often lasts three to four months and the goal is to improve the patient interpersonal skills and thus their interactions with others

brain stimulation therapy
brain stimulation therapies are used as the last resort on patients who had no response to anti depressant drug and psychosocial therapy in addition to patients who are suicidal the most common form of brain stimulation therapy is electroconvulsive therapy which involves passing current through the brain in order to stimulate seizure produces fast response and has been noted to be more successful than drug therapy nausea and short term memory loss may occur as side effects of the treatment

the national institute of clinical excellence recommends the combined use of anti depressants and high intensity psychological intervention to treat severe depression for cases of mild to moderate depression cognitive behavioural therapy self help therapy and participation in group physical activity are suggested

conclusion
by evaluating rebecca symptoms it could be drawn that rebecca is having moderate to severe depression episode in line with recommendation the doctor may feel it appropriate to prescribe an drug and arrange for rebecca the main benefit of are that they are less dangerous due to lower toxicity and fewer side effects than the other classes amongst the high intensity psychological interventions is more suited to rebecca as she is struggling with pessimistic thoughts about her ability rather than with her relationships as rebecca is younger than it would be recommended to review her case week after the commencement of her treatment due to the risk of increased suicidal thoughts which is side effect of antidepressant drugs as is expected from any consultations the doctor must make sure to explain the diagnosis and possible treatment options to rebecca ensuring that her views about her care are taken into account

Appendix FF Further ANOVA Analysis

Descriptives

				Statistic	Bootstrap[a] Bias	Bootstrap[a] Std. Error	Bootstrap[a] 95% Confidence Interval Lower	Bootstrap[a] 95% Confidence Interval Upper
Medical Students Overall Response on Technical Vocabulary on the Pre-test	L1	N		95	0	0	95	95
		Mean		3.6817	-.0042	.1274	3.4288	3.9330
		Std. Deviation		1.29092	-.01343	.08605	1.11714	1.44716
		Std. Error		.13245				
		95% Confidence Interval for Mean	Lower Bound	3.4187				
			Upper Bound	3.9447				
		Minimum		1.09				
		Maximum		6.77				
	L2	N		20	0	0	20	20
		Mean		3.3230	.0050	.2274	2.8850	3.7710
		Std. Deviation		1.04346	-.04075	.15454	.70739	1.30532
		Std. Error		.23332				
		95% Confidence Interval for Mean	Lower Bound	2.8346				
			Upper Bound	3.8114				
		Minimum		.79				
		Maximum		5.00				
	Total	N		115	0	0	115	115
		Mean		3.6193	-.0026	.1124	3.3973	3.8398
		Std. Deviation		1.25468	-.01169	.07642	1.09608	1.38927
		Std. Error		.11700				
		95% Confidence Interval for Mean	Lower Bound	3.3875				
			Upper Bound	3.8511				
		Minimum		.79				
		Maximum		6.77				
Medical Students Overall Response on Technical Vocabulary on the Post-test	L1	N		95	0	0	95	95
		Mean		6.4794	-.0016	.1000	6.2850	6.6648
		Std. Deviation		.96034	-.01210	.09326	.76100	1.12816
		Std. Error		.09853				
		95% Confidence Interval for Mean	Lower Bound	6.2838				
			Upper Bound	6.6751				
		Minimum		3.17				
		Maximum		8.75				
	L2	N		20	0	0	20	20
		Mean		6.2896	-.0025	.2460	5.7942	6.7746
		Std. Deviation		1.07400	-.03780	.12628	.76698	1.28953
		Std. Error		.24015				
		95% Confidence Interval for Mean	Lower Bound	5.7869				
			Upper Bound	6.7922				
		Minimum		4.24				
		Maximum		8.12				
	Total	N		115	0	0	115	115
		Mean		6.4464	-.0018	.0940	6.2627	6.6230
		Std. Deviation		.97874	-.00948	.07761	.81498	1.12356
		Std. Error		.09127				
		95% Confidence Interval for Mean	Lower Bound	6.2656				
			Upper Bound	6.6272				
		Minimum		3.17				
		Maximum		8.75				
Medical Students Overall Response on Sub-Technical Vocabulary on the Pretask	L1	N		95	0	0	95	95
		Mean		5.3145	-.0031	.1361	5.0326	5.5870
		Std. Deviation		1.37099	-.01219	.10585	1.15598	1.56706
		Std. Error		.14066				
		95% Confidence Interval for Mean	Lower Bound	5.0352				
			Upper Bound	5.5938				
		Minimum		1.02				
		Maximum		7.56				
	L2	N		20	0	0	20	20
		Mean		4.8055	.0029	.2773	4.2295	5.3544
		Std. Deviation		1.27427	-.03866	.15970	.89609	1.51577
		Std. Error		.28493				
		95% Confidence Interval for Mean	Lower Bound	4.2091				
			Upper Bound	5.4019				
		Minimum		2.31				
		Maximum		6.46				
	Total	N		115	0	0	115	115
		Mean		5.2260	-.0021	.1219	4.9838	5.4738
		Std. Deviation		1.36310	-.00938	.09156	1.17057	1.53611
		Std. Error		.12711				
		95% Confidence Interval for Mean	Lower Bound	4.9742				
			Upper Bound	5.4778				
		Minimum		1.02				
		Maximum		7.56				
Medical Students Overall Response on Sub-Technical Vocabulary on the Post-test	L1	N		95	0	0	95	95
		Mean		7.3227	-.0029	.1002	7.1066	7.5098
		Std. Deviation		.94948	-.01321	.10084	.73505	1.14704
		Std. Error		.09742				
		95% Confidence Interval for Mean	Lower Bound	7.1293				
			Upper Bound	7.5162				
		Minimum		3.58				
		Maximum		9.26				
	L2	N		20	0	0	20	20
		Mean		6.9105	-.0020	.2242	6.4871	7.3498
		Std. Deviation		.96090	-.03742	.10320	.69361	1.10432
		Std. Error		.21486				
		95% Confidence Interval for Mean	Lower Bound	6.4608				
			Upper Bound	7.3602				
		Minimum		5.67				
		Maximum		8.48				
	Total	N		115	0	0	115	115
		Mean		7.2510	-.0028	.0914	7.0614	7.4254
		Std. Deviation		.96014	-.01052	.08132	.79401	1.12184
		Std. Error		.08953				
		95% Confidence Interval for Mean	Lower Bound	7.0737				
			Upper Bound	7.4284				
		Minimum		3.58				
		Maximum		9.26				
prodSub	L1	N		95	0	0	95	95
		Mean		8.8215	-.0023	.1673	8.4908	9.1689
		Std. Deviation		1.62965	-.01330	.12869	1.36910	1.86954
		Std. Error		.16720				
		95% Confidence Interval for Mean	Lower Bound	8.4895				
			Upper Bound	9.1535				
		Minimum		5.09				
		Maximum		14.23				
	L2	N		20	0	0	20	20
		Mean		9.0780	-.0029	.3908	8.3557	9.8689
		Std. Deviation		1.70551	-.06216	.22922	1.18107	2.05538
		Std. Error		.38136				
		95% Confidence Interval for Mean	Lower Bound	8.2798				
			Upper Bound	9.8762				
		Minimum		6.50				
		Maximum		12.51				
	Total	N		115	0	0	115	115
		Mean		8.8661	-.0024	.1527	8.5745	9.1708
		Std. Deviation		1.63835	-.01060	.11512	1.40641	1.85354
		Std. Error		.15278				
		95% Confidence Interval for Mean	Lower Bound	8.5634				
			Upper Bound	9.1687				
		Minimum		5.09				
		Maximum		14.23				
ProdTech	L1	N		95	0	0	95	95
		Mean		5.0465	-.0080	.1768	4.7007	5.4043
		Std. Deviation		1.67228	-.00982	.13609	1.40380	1.94531
		Std. Error		.17157				
		95% Confidence Interval for Mean	Lower Bound	4.7059				
			Upper Bound	5.3872				
		Minimum		.93				
		Maximum		10.51				
	L2	N		20	0	0	20	20
		Mean		4.6470	-.0040	.5114	3.8120	5.7774
		Std. Deviation		2.36250	-.24317	.87169	.88849	3.66701
		Std. Error		.52827				
		95% Confidence Interval for Mean	Lower Bound	3.5413				
			Upper Bound	5.7527				
		Minimum		1.91				
		Maximum		13.50				
	Total	N		115	0	0	115	115
		Mean		4.9770	-.0073	.1690	4.6653	5.3063
		Std. Deviation		1.80535	-.01757	.19724	1.44237	2.19568
		Std. Error		.16835				
		95% Confidence Interval for Mean	Lower Bound	4.6435				
			Upper Bound	5.3105				
		Minimum		.93				
		Maximum		13.50				

a. Unless otherwise noted, bootstrap results are based on 1000 stratified bootstrap samples

Appendix GG Robust Tests of Equality of Means

Robust Tests of Equality of Means

		Statistic[a]	df1	df2	Sig.
Medical Students Overall Response on Technical Vocabulary on the Pre-test	Welch	1.787	1	32.534	.191
	Brown-Forsythe	1.787	1	32.534	.191
Medical Students Overall Response on Technical Vocabulary on the Post-test	Welch	.535	1	25.787	.471
	Brown-Forsythe	.535	1	25.787	.471
Medical Students Overall Response on Sub-Technical Vocabulary on the Pretask	Welch	2.566	1	29.040	.120
	Brown-Forsythe	2.566	1	29.040	.120
Medical Students Overall Response on Sub-Technical Vocabulary on the Post-test	Welch	3.053	1	27.380	.092
	Brown-Forsythe	3.053	1	27.380	.092
prodSub	Welch	.380	1	26.806	.543
	Brown-Forsythe	.380	1	26.806	.543
ProdTech	Welch	.517	1	23.168	.479
	Brown-Forsythe	.517	1	23.168	.479

a. Asymptotically F distributed.

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