UNIVERSITY OF SOUTHAMPTON

FACULTY OF ENGINEERING AND THE ENVIRONMENT

Institute of Sound and Vibration Research

A Quantitative Approach to Analysing Conversational Turn-Taking in Alzheimer's Disease and Frontotemporal Dementia

by

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Thesis for the degree of Doctor of Philosophy

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ABSTRACT

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A QUANTITATIVE APPROACH TO ANALYSING CONVERSATIONAL TURN-TAKING IN ALZHEIMER'S DISEASE AND FRONTOTEMPORAL DEMENTIA

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Communicating and understanding words require a wide range of cognitive resources involving phonological, lexical, semantic and perceptual processing. Disturbance in these domains is associated with pathology in temporal and/or frontal cortical areas. The subsequent abnormal breakdown in fluent speech can be observed in frontotemporal dementia or Alzheimer's disease, in which brain atrophy in these areas is common. Organization and interaction during a conversation depend, additionally, on the ability to plan and exchange information. Such executive resources are required for structuring, planning, monitoring and organizing speech output, and are impaired when critical networks in dorsolateral prefrontal brain regions become disrupted.

The aim of this study was to identify speech parameters, to characterise and describe the subgroups of dementia which could be used to improve the correct identification of dementia types at an early stage of the disease. Our analysis was based on the interactional organization of conversations and overlapping behaviour. As a new approach in speech analysis of dementia, we aimed to develop a method to quantify traditionally qualitative measurements.

We carried out two studies: In the first we recorded conversations elicited using a map task in healthy subjects paired with a familiar or an unfamiliar partner. We aimed to identify candidate parameters for characterising conversational behaviour and to investigate the existence of a Familiarity effect. Twenty-four conversations were recorded: twelve between familiar pairs and twelve between unfamiliar pairs. Conversations were analysed for overlap behaviour in the categories Confirmations, Predictions, Full Turn-Taking, Failed Turn-Taking, Failed Turn-Taking Completed and Others.

In the second we recorded nine Alzheimer's disease patients and three frontotemporal dementia patients using the same methodology of pairing, conversation stimulation and analysis as for the healthy subjects. The familiar partner was a family member or carer and the unfamiliar was a research assistant. For the patients recording sessions were repeated every three to eight months over a period of a year.

Analysis showed that the chosen experimental design and the parameters describing planning and executive abilities in speech are promising in terms of supporting our main research question on the subject of finding characteristic conversational behaviour in subtypes of dementia. We also found indicators for the Familiarity effect in healthy and dementia speech.

The case studies, which we conducted for three FTD patients, allowed providing an insight in to certain turn-taking behaviour by using examples of the transcripts. Again, we found that Familiarity is a promising indicator in conjunction with the categorical analysis for characterising FTD speech.

We demonstrated changes in the underlying structure of Alzheimer's disease and frontotemporal dementia speech with respect to the frequency of overlaps and outlined speech strategies of the patients to bypass cognitive limitations over time.

ABSTRACT

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Declaration of Authorship

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

A Quantitative Approach to Analysing Conversational Turn-Taking in Alzheimer's Disease and Frontotemporal Dementia

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. None of this work has been published before submission.

Signed:

Date: 22/08/2016

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List of Abbreviations

ACE-R	Addenbrooke's Cognitive Examination-Revised
AD	Alzheimer's Disease
bvFTD	Behavioural Variant of FrontoTemporal Dementia
CA	Conversation Analysis
F	Familiar
FaiTTC	Failed Turn-Taking Completed
FaiTT	Failed Turn-Taking
FTD	FrontoTemporal Dementia
FTT	Full Turn-Taking
HF	High-Frequency
L	Lead
LCT	Lille Communication Test
LF	Low-Frequency
NL	Non-Lead
NP	Noun Phrase
NVC	Non-Verbal Communication
PNFA	Progressive Non-Fluent Aphasia
SD	Semantic Dementia
TCU	Turn Construction Unit
ToM	Theory of Mind
TRP	Transition Relevance Place
UnF	Unfamiliar
VC	Verbal Communication
VP	Verb Phrase

Chapter 1 Introduction

According to the Alzheimer's Society there are around 800,000 people in the UK with dementia. The number of people who are developing dementia is increasing due to the fact the people are living longer. The NHS declares that in 2021, the number of people with dementia in the UK will have increased to one million.[1] Therefore, the dementia research community is working under intense pressure to develop a cure for dementia and find parameters that can describe and identify the different kinds of dementia at an early stage of the disease to ensure correct treatment.

The purpose of this research was to find speech parameters which can characterise and describe the following dementia groups: Alzheimer's disease (AD) and frontotemporal dementia (FTD) including its sub-groups: progressive non-fluent aphasia (PNFA), semantic dementia (SD) and behavioural-variant frontotemporal dementia (bvFTD). It is well known that these dementia groups have speech and language difficulties, which can become amplified during the course of the disease. The subgroups are known to show different behaviours such as disinhibited, withdrawn and repetitive speech behaviour. We hypothesise that their conversation structures will reveal parameters, which can differentiate the groups early in the onset of dementia.

Communication and understanding of words require a range of resources such as lexical, semantic and perceptual processing. The organization and interactions during conversation depend on the ability to plan and to exchange information (Peelle and Grossman, 2008). These executive functions, such as structuring and organizing, may be impaired when brain networks are disrupted. Language processing is particularly disturbed when temporal and frontal cortical areas are affected (McKhann et al., 2001). The subsequent abnormal breakdown in fluent speech can be observed in frontotemporal dementia or Alzheimer's disease, in which brain atrophy in frontal and/or temporal area(s) is common. Recently, progress in research on clinical, neuroimaging and pathology has improved the understanding of the emergence, development and the different stages of speech performance in the progress of FTD (SD, PNFA, bvFTD) and AD (Piguet et al., 2009).

Although the pure speech impairments in PNFA, SD and AD are well reported, studies of language in bvFTD, with its symptoms of change in personality and social behaviour are rare (Peelle and Grossman, 2008).

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[1] http://www.nhs.uk/conditions/Alzheimers-disease/Pages/Introduction.aspx

It is notable that the ability to participate in spontaneous conversations is not often considered and not well studied in any dementia group though the loss of conversational skills significantly affects the quality of life of dementia patients (Clare and Shakespeare, 2004). In this work we were therefore interested in conversational behaviour and specifically in overlapping. Overlapping is especially relevant to explore as dementia patients do show a delay in their speech and turn-taking initiation due to lack of working memory and difficulties in processing speech, often causing overlaps in conversations (Jones et al., 2016; Rhee et al., 2001). Therefore, the occurrence of different types of overlaps in speech may be a good indicator of the severity of the disease and may characterise subgroups of dementia as well.

We wished to investigate the differences in overlapping in conversations between two healthy people and between a healthy person and person with dementia. We were also interested in the differences between conversations involving those with Alzheimer's disease and those with Frontotemporal dementia. Further we wished to explore the change in conversation in the dementia patients over time as the disease progressed. Additionally we were interested in exploring the possible existence of a Familiarity effect in healthy and dementia conversational interactions because there is some evidence in the literature (Lepeleire et al., 1998; Steeman et al., 2006) that patients with dementia may behave in a way that masks speech and language effects of the disease in conversations with less familiar people such as clinicians. If so, this has implications for the design of protocols for gathering reliable diagnostic or monitoring data.

In this work we undertook two studies, a healthy study in which we analysed 24 recordings and a patient study for which we recorded 27 conversations including dementia patients as conversational partners.
We analysed the recorded conversations of healthy subjects in terms of overlaps, classifying them into six categories. Applying the same classifications to conversations including dementia patients, we used both quantitative and qualitative methods to investigate the usefulness of the categories in characterising their speech behaviour. We compared behaviour statistically between healthy pairs and healthy-AD pairs and we made a case study analysis of each of the FTD subtypes. Longitudinal analysis was also carried out on a small sample of subjects who we were able to record more than once over the duration of the study.

1.1 Report structure

In the following report, a detailed outline of speech and language behaviour of dementia patients as well as the experimental aspects of this study, which aims to discover speech parameters that are able to indicate differences and/or characterisations of the subgroups, will be presented.

After a short introduction to the clinical background of dementia subgroups, a literature review exhibiting the status quo in speech and conversation analysis in dementia will be provided. In the context of speech changes, which may appear in the progress of the disease, the so-called “Familiarity effect” will be explained and set with reference to patients’ behaviour during conversation (Chapter 2).

In Chapter 3, research about Conversation Analysis and turn-taking will be introduced as a method of analysing speech in dementia.

The next chapter will focus on our research questions, covering the problem of misdiagnosis of FTD at an early stage of the disease and the possibility of using turn-taking features as tools to describe and differentiate the subgroups of dementia.

The 5th Chapter will illustrate the experiment design for the healthy and patient studies. Both studies were based on the performance of the so-called map task, generating spontaneous speech for our analysis.

The following chapter will draw an outline of expectations for the outcome of each study, based on literature about speech in dementia.

Chapter 7 and 8 will include the statistical data analysis of conversations from healthy participants and patients. Moreover, possible changes in conversational behaviour will be analysed for some AD speakers (Chapter 8.3 and 8.4).

In Chapter 9, a comparison between the healthy and the patient/AD data sets will be presented.

The following chapter will discuss FTD case studies and the changes in speech behaviour observed during the progress of the diseases will be described in detail.

The experimental outcomes will be summarised and an evaluation of the suitability of the method chosen will be given in the final chapter. An outlook for future work will be presented in Chapter 11 as well.

Chapter 2 Speech in Dementia

This chapter will give an overview of the subgroups of dementia and their speech and language impairments as well as an outline of linguistic information about conversation structures in AD and FTD speech. Based on the literature findings, we will define our first (section 3 of Chapter 2) and second (section 4 of Chapter 2) research question in order to characterise and describe these groups of dementia regarding their turn-taking behaviour.

2.1 Introduction

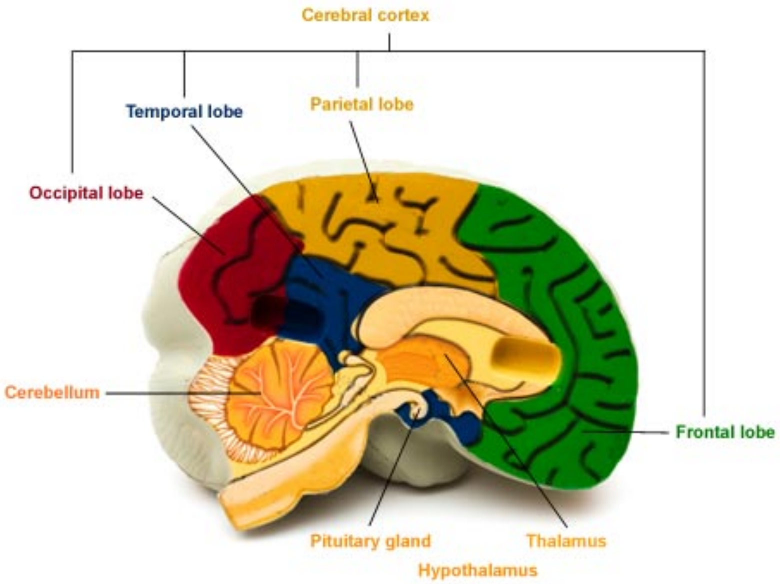

Figure 1 The brain and its areas (www.health24.com)

In general, dementia is defined as a syndrome characterized by: loss of intellectual capacity in learning, memory, language abilities, reading and writing; difficulties in environmental interpretation, and in processing visuospatial information. Moreover, behavioural disturbances such as affective, anxiety and psychotic disorders are common. In the later stages of dementia, basic biologic functions are reduced, all speech and language abilities are lost and several neurologic abnormalities develop (Garand et al., 2000).

The diagnosis of AD (Alzheimer et al., 1995) requires syndromes of dementia and postmortem neuropathological confirmation of amyloid-containing neuritic plaques (extracellular deposits in the grey matter of the brain) as well as neurofibrillary tangles (also known as tau protein which is bundled) in specific brain areas: throughout the cerebral cortex and hippocampus. It is well reported that the loss of neurons of association cortices and in nuclei and loss of synapses correlates with the brain atrophy occurring in dementia (Terry et al., 1991). Normally, the cerebral atrophy is found postmortem in brains of persons with AD.

In FTD, also known as Pick's Disease affect, according to Garand et al. (2001), 10-15% of dementia patients are most commonly misdiagnosed as having psychiatric disorders (McKhann et al., 2001; Rascovsky et al., 2011). Positron Emission Tomography (PET) shows changes in the metabolism of an affected brain, also the blood flow is distinguishable from other diseases (Garand et al., 2000). The cause of FTD is still unknown although a relation to chromosome 17 is assumed. In the literature, subgroups of FTD are classified as progressive non-fluent aphasia (PNFA), semantic dementia (SD) and behavioural variant FTD (bvFTD) (Mioshi et al., 2010; Peelle and Grossman, 2008; Rousseaux et al., 2010).

2.2 The Clinical Aspect of Speech in Dementia

Before going into the detailed literature analysis and the status so-far concerning AD and FTD speech and language, a brief description of the pure speech impairments of the different subtypes will be given below with reference to the affected brain regions. A profound knowledge of the subgroups' specific limitations is considered as a suitable introduction to the conversational behaviour of dementia patients as presented in the literature.

1. Alzheimer's disease

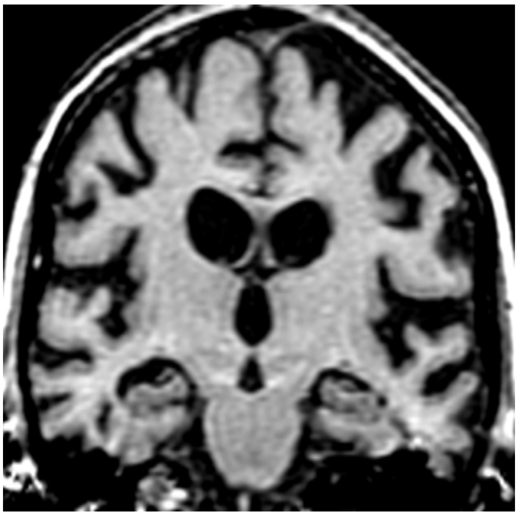

Figure 2 Image of an AD brain (private source)

Alzheimer's disease is characterized by memory and several cognitive deficits caused by brain atrophy (Rousseaux et al., 2010). Their memory decline encompasses spatial memory, the semantic long-term memory and the working memory (MacDonald et al., 2001).
According to (McKhann et al., 2011) the diagnostic criteria for AD are multi-faceted and require that a set of core clinical criteria for all-cause dementia, which may include impaired language

functions such as difficulty thinking of common words, hesitations, and speech errors, are met and that in addition, there is:

1. Insidious onset
2. Clear-cut history of worsening cognition
3. Either deficit in learning and recall of recently learned information (amnestic presentation) or, in non-amnestic presentation, deficit in language, especially word finding, and/or deficit in spatial cognition and/or executive dysfunction.

By the middle stage of the disease, AD speakers show deficits in naming, paraphasic errors and semantic jargon. In advanced stages, global aphasia and mutism are present (Blair et al., 2007) . Spontaneous speech is highly affected perhaps caused by the lack of “pre-emptive planning or memorization of a response” (Guinn & Habash, 2012, p.8). Perseverated repetitional abilities and impaired auditory comprehension are also observed. Semantics and pragmatics are impaired rather than syntax and phonology (Murdoch et al., 1987; Singh et al., 2001).

In 1991, Ripich et al. found evidence that AD speakers are aware of their own confusion and tend to ask many “direct, forced choice questions to gain additional information” (Ripich et al., 1991, p.338).

Very early in the course of AD, neuropathological changes are seen in the entorhinal cortex, which is located at the rostral end of the temporal lobe. A recently introduced term in the context of AD is mild cognitive impairment (MCI). The criteria for MCI are amongst others a subjective complaint about memory loss, objective impairment of ability, preserved general cognitive function and the person not meeting the criteria for dementia. However, MCI is considered as a pre-stage of AD; Patients with a diagnosis of MCI are at an increased risk for developing AD (Taler and Phillips, 2008).

2. Frontotemporal dementia

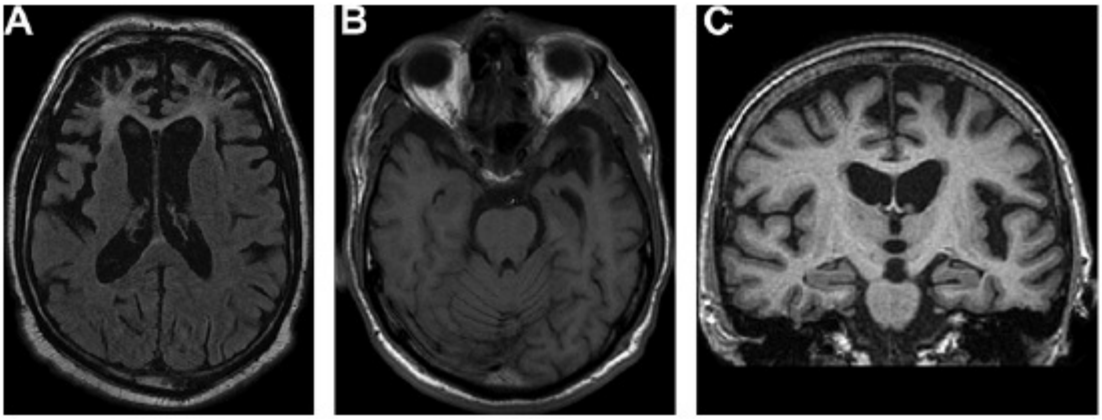

Figure 3 Image of FTD subtypes. (A) Frontal atrophy (bvFTD). (B) Left temporal lobe atrophy (SD). (C) Left inferior frontal and superior temporal atrophy (PNFA) (www.sciencedirect.com, private source)

Semantic Dementia

The International Consensus Criteria for diagnosis of Semantic Dementia require (Gorno-Tempini et al., 2011) that :

1. The most prominent clinical feature is difficulty with language
2. These deficits are the principal cause of impaired daily living activities
3. Aphasia should be the most prominent deficit at symptom onset and for the initial phases of the disease

Further, for a diagnosis of Semantic Dementia (also known as semantic variant PPA) there should be both:

1. Impaired confrontation naming
2. Impaired single-word comprehension

And at least 3 of the following:

1. Impaired object knowledge, particularly for low-frequency or low-familiarity items
2. Surface dyslexia or dysgraphia
3. Spared repetition
4. Spared speech production (grammar and motor speech)

People with SD speak fluently, but their speech may convey relatively little information (Peelle and Grossman, 2008). SD speech is grammatically well-formed; syntax, phonology and articulation are relatively preserved (Hodges and Patterson, 1996). However, SD speakers may have significantly slower speech than healthy people (Ash et al., 2009).

The major symptom of SD is, as its name suggests, disturbed semantic processing. According to Peelle and Grossman (2008), SD speakers exhibit word-finding pauses, circumlocutions and expressions that substitute for specific nouns (e.g. “thing” or “stuff”), though frequently used and familiar objects make a positive contribution to their semantic processing. For words whose meaning has been lost, phonological mistakes can be observed. Further, some SD speakers show difficulty in pronunciation or writing of irregularly spelled words. Nevertheless, SD speakers present preserved phonological processing (Peelle and Grossman, 2008).
Cortical atrophy affects ventral, lateral and anterior temporal lobes bilaterally (Ash et al., 2009; Peelle and Grossman, 2008).

Progressive non-fluent aphasia

The international consensus criteria for the diagnosis of progressive non-fluent aphasia are (Gorno-Tempini et al., 2011) that at least one of the following core features must be present:

1. Agrammatism in language production
2. Effortful, halting speech with inconsistent speech sound errors and distortions (apraxia of speech)

And at least 2 of the 3 following other features must be present:

1. Impaired comprehension of syntactically complex sentences
2. Spared single-word comprehension
3. Spared object knowledge

PNFA is a disorder affecting expressive language where the working memory is impaired (Adenzato et al., 2010; Peelle and Grossman, 2008). PNFA speech is characterized by effortful speech production, grammatic and phonological errors as well as difficulties in word retrieval (Neary et al., 1998). PNFA speakers show high rates of phonological paraphasias in naming (e.g. “papple” for apple, “plants” for pants), reading aloud and in word repetition (Grossman, 1996; Peelle and Grossman, 2008). According to Peelle and Grossman (2008), semantic knowledge is relatively well-preserved. Their observations are in accordance with the results of Grossman et al. (1996) who noted that PNFA speakers are impaired “[...] on grammatical phrase structure aspects in sentences comprehension and expression, phonemic judgements, repetition [...]” (Grossman, 1996).
Gorno-Tempini et al. (2011) note that the agrammatism takes the form of speech with short, simple phrases, inflections and omissions of grammatical morphemes. The effortful speech production was thought to be due to the PNFA patient's deficit in articulatory planning which leads to inconsistent speech sound errors (Gorno-Tempini et al., 2011). They further remark that

the speech sound errors such as distortions, insertion, substitutions etc., are often noticed by the speakers themselves.

The approximate impaired area is the left inferior frontal cortex; patients show atrophy in left frontal cortex, anterior insula, dorsolateral prefrontal cortex and superior temporal cortex (Peelle and Grossman, 2008).

Behavioural-variant frontotemporal dementia

bvFTD is characterised by a change in personality (Mikesell, 2009) and social behaviour with “apathy and/or disinhibition, emotional blunting, stereotyped or ritualised behaviours, loss of empathy, alterations in appetite and food preference with limited or no insight” (Lillo and Hodges, 2009). The international consensus criteria for the diagnosis of bvFTD are given by Rascovsky et al. (2011) as:

> 1. Shows progressive deterioration of behaviour and/or cognition by observation or history (as provided by a knowledgeable informant)
> and 2 or 3 of the following:
>
> - Early behavioural disinhibition;
> - Early apathy or inertia;
> - Early loss of sympathy or empathy;
> - Early perseverative, stereotyped or compulsive/ritualistic behaviour;
> - Hyperorality and dietary changes;
> - Neuropsychological profile: executive/generation deficits with relative sparing of memory and visuospatial functions;

where early is in the first 3 years. Within the fourth subcategory: perseverative behaviour, one of the symptoms may be stereotypy of speech. Thus altered speech patterns are only one of a very large number of changes that may be observed in this dementia subgroup.

In bvFTD, executive dysfunction is thought to account for language impairments resulting in deficits in naming and sentence comprehension as well as discourse processing problems (Peelle and Grossman, 2008; Piguet et al., 2009). It has been shown that bvFTD speakers have a profound impairment in judging the intentions of others which has an impact on their conversational abilities (Eslinger et al., 2012; Leyton and Hodges, 2010; Peelle and Grossman, 2008).

In order to predict intentional behaviour, interlocutors interpret each other’s behaviours which are caused by beliefs, hopes and wishes. Levelt (1999) named this interpretation ability the “Theory of Mind” (ToM). Levelt (1999, p.85) noted that the ToM allows conversational partners to

build up complex structures of knowledge about social attitudes: “Over and above registering Who did What to Whom, we encode such complex states of affairs as 'A knows that B did X', 'A believes B did X', 'A hopes B does X', 'A fears that B does X', 'A erroneously believes that B knows X', 'A doesn't know that B hopes X', and so on''.
Orbital and mesial frontal lobes are involved in bvFTD’s pathology.

2.3 Dementia Subgroups and their Speech and Language Difficulties

Over recent years research progress in clinical characteristics, neuroimaging and pathology has improved understanding of FTD and AD. Although the speech impairment in PNFA, SD and AD is well reported, studies about language in bvFTD are rare. However, some of them will be reviewed in the following, focussing on the bvFTD results but considering all other subtypes as well.
There is evidence that in a clinical environment, patients tend to conceal their speech difficulties with a less familiar person (e.g. GP) (Clare and Shakespeare, 2004; Maynard and Heritage, 2005). Relatives often report that the patient is quite normal in the clinic but different otherwise (Mikesell, 2009). The importance of social interaction should therefore be included in any study based on a conversational approach. The existence of a Familiarity effect in FTD and AD could be useful for characterisation of the discussed groups and therefore be an advantage for diagnosis. The effect will be explained in more detail later on. However, to date the existence or otherwise of such an effect has not been explored in the literature about dementia.

In general, a research aim in FTD and AD is finding parameters which can classify and differentiate the disease in these subgroups of dementia. The correct diagnosis at an early stage of dementia increases the opportunity for appropriate management and/or therapeutic intervention. In the following section, AD and FTD studies with the focus on conversation and turn-taking will be presented.
Cycyk and Harris Wright (2008) gave a literature overview regarding the current definition and differential diagnosis in FTD and AD and the confusion about it. They stated: “Patients with FTD are frequently misdiagnosed as presenting with Alzheimer’s dementia due to limitations in the literature describing the differing profiles of the two populations.”((Cycyk and Harris Wright, 2008) p. 422)). They draw the conclusion that using speech-language pathology intervention may result in a successful approach to defining the subtypes of dementia.
In 2009, Piguet et al. tried to demonstrate the sensitivity of current FTD criteria which are nowadays used for classifying this disease. A total of 45 patients with bvFTD (> 3 years) were studied and judged for the presence of core features (loss of insight, emotional blunting, impairment in personal conduct, decline in social interpersonal conduct, insidious onset) and in supportive features (behavioural disorder, speech and language (speech pressure (speaking

rapidly and without inhibition), speech aspontaneity, stereo- type/echolalia, mutism), physical signs) by an independent neurologist.

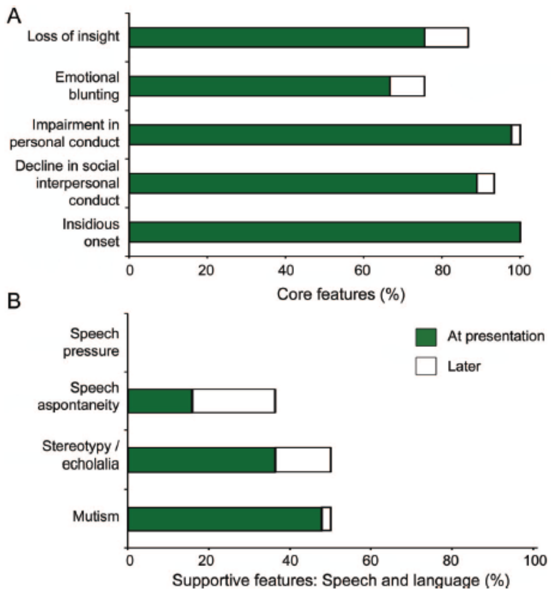

Figure 4 Prevalence of core features (A) and speech and language supportive features (B) of bvFTD at initial presentation and with disease progress ((Piguet et al. 2009), p.734)

Just 58 % of the cases exhibited all five core features which are deemed necessary for a clinical diagnosis (examination for the first time). The supportive features had low prevalence and were not sufficient to classify bvFTD patients precisely (Figure 4). The authors concluded that the current diagnostic is not reliable to identify FTD in early stage. Though this study revealed some interesting results, Piguet et al. (2009) only considered the surface of diagnostic criteria. A more detailed and differentiated analysis, for example within the supportive features “speech and language”, might have shown a higher agreement score. Further, the evaluated information, mostly taken from third persons, cannot serve as a good analysis base for an objective evaluation. Moreover, a comparison group was not considered. Results of a non-FTD group could have shown the relevance of the specificity in the chosen criteria/core/supportive features.

For improving diagnostic features, many researchers have focussed on finding innovative and promising parameters in speech and language which are significantly reliable to set a correct and early AD and FTD identification:

In 1991, Ripich et al. focussed on the linguistic aspects of AD speech. They found evidence that AD patients are aware of their own confusion and tend to ask many “direct, forced choice questions to gain additional information” ((Ripich et al., 1991), p.338). The authors looked at conversational discourse patterns in 11 healthy elderly and 11 AD patients by using a dyadic interaction with an interviewer (examiner). The speech was audio- and video recorded and took place during a coffee break between testing consultations. The examiner acted as a peer and was instructed to avoid “interviewing” the patient. Measurements were taken on the basis of number of words spoken, conversational turns and speech act types (communicative intents). The results revealed that AD and control data show significant differences in turn taking and word usage which was, in comparison to the healthy participants, reduced. The AD patients used more turns (briefer utterances, high amount of requestives) in order to participate effectively. However, conversational skills (form and communicative intent) were sustained. According to the authors the interactions were still recognizable as conversational turn-takings. However, the authors did not consider the impact of familiarity. All participants were unfamiliar with the interviewer, which may have had an impact on the conversational structure.

A further case study of conversation in AD was published by Sabat (1991). He analysed the speech of an AD patient focussing on turn-taking and turn-giving. The author recorded eight conversations with a 75 year old female AD patient over a period of 2.5 months, with one conversation per week. Each recording lasted about one hour. He noted that the patient made numerous mistakes both semantic and phonemic and frequently used circumlocutions. Her performance in memory, concept formation and word finding was limited. The conversations were structured as an interview guided by the researcher himself, which may lead to the question of a biased approach as well as of potentially leading the AD patient to a certain outcome. Sabat (1991) measured/counted the number of turns, the duration of speech segments of the patient and the number of pauses. He presented two analysed conversations to illustrate the main concept of his research. The author reported that the patient made 34 gaps or pauses (sum of both conversations), which were significantly longer in their duration than appropriate. However, he did not provide any comparable “healthy” and appropriate values for pause or gap duration. He came to the conclusion that the conversations were unsuccessful based on the observation that turn-taking traditions were not followed by the AD patient. He noted that during longer pauses or gaps, he avoided taking the turn himself to give his interlocutor the opportunity to formulate her ideas and thoughts. In fact, he broke the rule “one speaker at a time” as he was obligated to take the turn since he wanted to keep the AD patient in the conversation. Sabat (1991) finally summarised that the speakers’ impaired social dynamics (cognitive abilities, emotional states, mutual commitment to communication) had led to long pauses and gaps (temporal economy). It should be noted, however, that the conversations may have been “unsuccessful” due to the fact that the conversational structure was not natural. The parameters the author was focussing on were limited and in the end not statistically significant enough to draw conclusions about the patient’s ability to participate in a conversation under normal conditions.

A recently published study of Sajjadi et al. (2012) compared conversation abilities of SD and AD patients with healthy participants (SD: 16, AD: 20 and healthy participants: 30). The authors used face-to-face interviews, which were semi-structured, and a picture description task to collect speech data. Sajjadi et al. (2012) were interested in the so-called T-units (Hunt, 1965) , but in a modified version which were classified as units that convey a clear message in a clause/different clauses, elliptical phrases, units which represent a failure of the speaker. Spontaneity (number of questions/encouraging comments) and rate (number of words per minute), fluency and phonological errors (e.g. hesitations, editing breaks), lexical content and semantic processing (e.g. number of verbs/minute, circumlocutions) and grammatical errors were also under examination. No difference could be observed between SD patients and healthy participants for phonological error frequency, discourse markers or syntactic errors. The data did not show an increased number of circumlocutions since the SD patients tended to avoid speaking about concepts for which their knowledge was already degraded. However, the AD patients showed a significant increase in the frequency of hesitation markers compared to the SD and control groups. Further, the authors confirmed impairment in semantic content and thematic coherence in AD speech. However, the researchers could not find a significant difference in the means for word repetition, (letter) fluency and sentence repetition in a comparison of AD and SD speech data. The outcome shows how challenging it is to find parameters that can characterise and differentiate the speech impairments of both dementia subtypes, considering the underlying features of conversational behaviour.

The research group around Rhee (2001) examined in detail at the role of grammatical, semantic and executive components in FTD, which are part of conversational structuring and planning. According to the authors, the difficulty in verbs arises from the different types of information, the aspects of meaning and grammar and the processing resources, which have to be handled. For their comparative study, 21 FTD patients (all three subgroups) participated in a word-picture matching procedure that involved judgements about verbs and nouns (Rhee et al., 2001). The patient had to decide whether the presented word and the picture went together. Across all groups, a low performance with verbs compared with nouns was observed. The test revealed that the interaction between resource demand (processing words, access to the mental lexicon) and word class was impaired in the bvFTD group whereas SD and PNFA patients seemed to have more category specific difficulties in verbs rather than in nouns. The observed comprehension problem with verbs could be, so Rhee et al. suggested, a part of a resource limitation that impairs the bvFTD patients' ability to process the information associated with a verb. In comparison to the SD (difficulty in understanding verbs) and PNFA patients (difficulty in sentence comprehension related to grammatical aspects), bvFTD patients showed a correlation between information-speed processing of executive resources and impaired verb comprehension. Obviously, the small amount of participants is a critical point considering the statistical power. The patient distribution, bvFTD: 10, PNFA: 7, SD: 4, is unbalanced and could affect the results. Nonetheless, the findings are confirmed by a study about slowed speech fluency in bvFTD patients by Ash et al. (2009).

Ash et al. (2009) published a paper about non-fluent speech in frontotemporal lobar degeneration. The authors outlined, by using background literature, that fluency is the ability to produce conversational speech in a flowing, effortless way. Furthermore, the retrieval of words from the mental lexicon, forming a structure to place words in a grammatical sentence and creating a motor speech program (Levelt, 1992), is the base for communication (interaction). In the study of Ash et al., all three subgroups of FTD were investigated under the aspect of speech fluency. 35 patients (11 PNFA: hesitant, effortful speech, phonetic and phonological errors, 12 SD: produced fewer nouns, 12 bvFTD: no noticeable word finding difficulties), all mildly impaired, as well as 10 healthy seniors participated in the experiment. The task was to tell the story of a children‘s picture book (“Frog. Where are you?” (Ash et al., 2009)). They minimized interruption to avoid turn-takings. The recordings of the narratives were transcribed (using Praat (Boersma, 2001)) and analysed for fluency (complete words per minute, speech errors per utterance, grammatical structure, content features (length (words) per utterance, complex grammatical structures per utterance, semantically limited sentences, verbs/nouns per utterance)). MRI scans were made to investigate the cortical atrophy. It was found that PNFA patients had the most impaired speech fluency (correlated with fewer verbs per utterance, not with nouns) and were significantly impaired in grammar and sentence structure measurements. The SD group had significantly slowed speech compared to the control group. Impairments included noun production, semantic content of sentences, comprehension and semantically mediated executive functioning. Only the grammatical production measures were intact. bvFTD patients produced significantly slowed speech and showed impairment accessing the mental lexicon. The executive measure of category naming fluency was correlated to the speech rate. Moreover, the patients showed impaired discourse with poorly organized expression, which may be related to a limitation of executive functioning. Ash et al. concluded that apathy and poor mental organization contributed to the reduced speech fluency. The authors found extensive frontal and temporal cortical atrophy in bvFTD patients and inferred from that the limited planning and organization in bvFTD speech. Though the arguments are well structured, the question of a reason for exclusion of turn-taking possibilities arises. This feature could have been useful to have a look at a complex grammar structure and the reorganisation of planning.

In 2006, Ash et al. focussed on the discourse impairment in frontotemporal dementia. They assumed that the impairment of executive resources (planning/organization) contributes to bvFTD’s discourse difficulty. The authors examined narratives told by 35 FTD patients from the picture book mentioned above. The transcribed narratives were analysed in duration, number of utterances/words, lexical retrieval difficulty, content, action, global connectedness, search theme and local connectedness. MRI scanners were used to evaluate the relationship between cortical atrophy and the local connectedness of narrative organization. All subgroups showed impairments in performing the task. SD patients had trouble with retrieving the words to express a narrative whereas PNFA patients were effortful in speech resulting in sparse narrative. Interestingly, the bvFTD patients found the individual words to describe a picture and also the syntax to combine words. However, their narratives lacked the elements of connectedness "needed to unite the elements of the story into a coherent whole" ((Ash et al., 2006), p.1441). In detail, they had difficulties in relating successive events to each other and the end of the story to the beginning. The difficulty of effectively expressing the point of the story shows the problem of organization of the narrative. The authors then hypothesized, that these impairments were related to limited executive resources such as organization, planning and working memory. Ash et al. finally concluded that the organisational deficit was related to the right frontotemporal disease due to activation in the right prefrontal and temporal regions, which is associated with the extraction of the overall meaning of long sentences and stories.

Rousseaux et al. (2010) picked this result up and analysed communication in conversation from patients with dementia. They compared AD, bvFTD and Dementia with Lewy Bodies, all suffering from mild or moderate dementia. A Lille Communication Test (LCT) was used to examine differences. The LCT is composed of participation in communication, verbal communication (VC) and non-verbal communication (NVC). All parts were analysed in three situations: natural interaction, a directed interview and an open discussion. In the latter condition, interlocutors were sitting at a table, each had similar images in front of them and one had to make the other work out what one of these images was by using speech or gestures. Additionally, the patient-interlocutor interaction was video recorded. The authors deduced that FTD patients showed the most severe communication disorders. AD patients showed more modest difficulties. They mainly demonstrated a reduction in their greeting behaviour. However, they showed no difficulties in engaging in interaction, neither for VC nor NVC. The authors noted that AD patients showed difficulties in words and sentences and in producing words due to their word finding difficulties. Rousseaux et al. (2010, p.3888) concluded that the results of the AD patients demonstrate impairment in their lexical-semantic processing and "[...] less severely […] difficulties of pragmatic or higher levels of language processing". The FTD patients showed that their participation in communication was heavily impaired, especially in greeting behaviour, attention to the interlocutor and engagement in conversation. Moreover, patients were impaired in word comprehension and word finding. Interestingly, pragmatic disorders were revealed as a severe impairment, for example in responding to open questions, presenting new information, organizing discourse, adapting to interlocutor knowledge and emitting feedback. As with Ash et al. (2006), the authors found difficulties for bvFTD patients in maintaining the topic of exchange, introducing a new theme and adapting to verbal feedback from the interlocutor (Rousseaux et al., 2010). Pragmatic difficulties could also be observed in NVC such as adapting prosody, using regulatory mimogestuality, managing speech turns and feedback. The authors concluded that all these impairments were responsible for the poor social interaction and isolation. However, it is questionable if the results comprised the entire communication situation. Although the authors gave arguments for an exclusion of known persons (e.g. variability of discussion, referential communication), an inclusion of family or well-known persons could have given a broader spectrum for a disease survey.

Cosentino et al. (2006) researched the understanding of context in bvFTD from a different point of view. They proposed a model of script comprehension, which included semantic knowledge for script content and executive resources responsible for organizing that knowledge into goal directed behaviour. The authors defined a script as a "[...] large-scale routine entailing the typical action sequence, objects, role players, and locations associated with familiar events like 'going fishing', 'making breakfast', 'going to a movie', or 'visiting the doctor'." ((Cosentino et al., 2006), p.307). These scripts guide human interaction and goal-directed behaviour. For detecting the components of script comprehension in dementia, 15 AD, 13 SD and 12 bvFTD patients (only mild to moderate) participated in their study. The selected scripts represented a variety of familiar events: each script was shown by title and four pictured events (familiar events) printed on a sheet of paper. All scripts were introduced under three conditions: correct condition, sequencing error condition (physically implausible or conceptually implausible) and semantic error condition. The participant was asked to decide whether the four activities presented made sense and asked to read the event aloud. All groups showed a significantly impairment at script comprehension. This was most evident in bvFTD patients due to their deficit in the organizational script component. Interestingly, bvFTD participants were more impaired in detecting sequencing errors than semantic errors. The authors defend these results by mentioning the executive dysfunction, which makes a contribution to the recognition of sequencing errors within a script. Though the paper of Cosentino et al. (2006) did not refer directly to the language of bvFTD, the results can be transferred to speech behaviour. The fact that the bvFTD patients in this study were not able to detect sequencing errors may represent the inability to interact in communication or participate in/follow a conversation due to their limited resources as mentioned above.

The consensus of the results mentioned is an awareness that dementia patients suffer from conversational and communication problems, which may result in introverted, repetitive and eccentric behaviour and/or speech.

In the beginning, we listed the speech impairments for each subtype of dementia and continued by showing their consequences for speech behaviour with the support of the literature. Through this review, it became clear that the task to characterise AD and FTD is challenging and their symptoms are overlapping. AD, SD and bvFTD share deficits in the conceptual preparation, in other words they have difficulties generating a "larger message that captures the speaker's communication" ((Levelt et al., 1999), p. 3). This limitation causes word-finding problems and hesitation markers (Ash et al., 2009; Rousseaux et al., 2010; Sajjadi et al., 2012), especially in AD and SD. bvFTD patients reveal difficulties in the discourse processing which is also part of the conceptual preparation (Ash et al., 2006). Slowed speech behaviour were shown in SD and bvFTD patients (Ash et al., 2009, 2006).

We also found shared speech difficulties for PNFA and bvFTD subgroups. The speech limitation, especially for PNFA, is manifested in the grammatical encoding which “takes a message as input and delivers a surface structure as output” ((Levelt, 1993), p.4). This structure organises syntactic phrases and is lexical driven. According to Levelt (1993), “Grammatical encoding is like solving a set of simultaneous equations: the surface structure must be such that for all lemmas the required syntactic environments are realized” ((Levelt, 1993), p.4). Lemmas are defined as lexical items which are phonologically undefined. PNFA and bvFTD showed limitations in speech fluency and grammaticality of speech production (Ash et al., 2009; Pakhomov et al., 2011) which may have been caused by difficulties in accessing (the correct) lemmas and their encoding. For further information about the stages of speech production and the implementation of dementia see appendix A.

Considering the overlapping of symptoms, there is a great need for parameters that are able to characterise and differentiate speech behaviour with a new approach.

We therefore define the first research questions of our study:

1. “Can the different types of dementia be characterised by their speech difficulties in conversation?”

In the abovementioned studies, either isolating word-naming tasks (Cosentino et al., 2006; Rhee et al., 2001) or guided interviews which were partly manipulated by reducing turn-takings or interruptions by the examiners (Ash et al., 2006; Rousseaux et al., 2010; Sabat, 1991; Sajjadi et al., 2012) have been conducted to assess speech in dementia.

Even though data collection with communicational interaction has been considered as a useful tool for looking for statistically significant differences in e.g. speech fluency, number of words, duration etc., researchers have, to date, missed the importance of spontaneous speech and conversation. We will fill that gap by using a speech task which is able to generate unbiased conversations. We will look for parameters that will describe the speech behaviour of AD, SD, PNFA and bvFTD in one study.

2.4 The Familiarity Effect

In addition to the speech/turn-taking analysis (see Chapter 3.1), we will evaluate a possible Familiarity effect in conversation with dementia. A Familiarity effect is the change in conversational structure when the interlocutor is known to the partner as compared to discourse with a stranger. In the context of our project, we will show that it is reasonable to expect the Familiarity effect as an influencing factor for discourse difference (conversation coordination), speech rate (speed of production) and disfluency (e.g. conversation break-down caused by violating a turn-taking rule) (Bortfeld et al., 2001; Yuan et al., 2007, 2006). In the literature, so far, this kind of Familiarity effect has not been considered with reference to all dementia subgroups and therefore, we consider an analysis as a potential tool for the project's aim of subgroup discrimination.

In 1999, Branigan et al. investigated how non-linguistic factors influence disfluency rates of spontaneous speech by using the map task (task-oriented dialogue: see also Chapter 5.2) to discover the differences between sex of the speaker, sex of the interlocutor/addressee, familiarity with the addressee and conversational roles. They also looked at the influence of the ability to see the addressee and the practice of the task (learning effect). In total, 64 speakers participated and were divided into 16 groups of 4 persons. In 8 quads the participants had eye contact and in the other 8 quads they could not see each other. Within each quad were two pairs of friends, but members of each pair were unfamiliar with the members of the other pair (Branigan et al., 1999). The disfluency was coded, for example, by the amount of repetition, deletion, repair and combination of disfluency items. The authors expected that the speaker might be more careful when speaking to an unfamiliar person due to the fact that the speaker makes a bigger effort in preplanning an utterance which results in a lower disfluency rate. Another approach was the assumption that the speaker could be more anxious when speaking to an unknown interlocutor resulting in a lower disfluency rate as well. The results concerning familiarity showed, in contrast to what the authors expected, that speakers had a higher discard rate when talking to a familiar addressee: more words needed to be removed to perform a fluent conversation. However, the familiarity did not affect the disfluency rate (number of disfluencies that were produced). As a conclusion Branigan et al. explained their result as an outcome of over simplification and suggested that other factors which were not considered are influential.

Bortfeld et al. (2001) continued the research and changed the familiarity from friends to married couples. They expected that people would be more disfluent with strangers because they might be more anxious. According to the authors, anxiety has a higher disfluency rate. Further, they thought that people would be more disfluent with intimates as utterances tend to be shorter (preplanning is reduced) and the rate of mistakes might increase. For their study, Bortfeld et al. recruited 48 pairs resulting in a corpus of 192,000 words. Each pair discussed objects from a familiar and unfamiliar topic. The task was about ordering a sequence of a card-set and the participant who acted as matcher got directions from his/her interlocutor. The members of a pair could not see each other, but could communicate freely. The authors got a similar result in disfluency rate to Branigan et al. (1999): for married pairs, conversations were no more fluent than conversations with strangers. Though the authors expected an increase of fluency within married pairs due to the fact that they might feel more comfortable, this hypothesis could not be verified. Interestingly, anxiety evoked within a conversation with an unfamiliar person did not show any increase in disfluency rate either. Even the expectation that strangers would plan their speech more carefully was falsified. A possible explanation could be that planning of speech or organization of turn-taking can be processed very quickly. This skill leads to the same disfluency rate in healthy speech with familiar and unfamiliar people. However, they did find a statistical difference for the overlap rate between married couples and strangers. Strangers overlapped each other’s speech more often than married couples. Unfortunately, the authors did not give any further explanation for their findings.

A few years later, Yuan et al. (2007) looked at overlap behaviour in more detail by comparing strangers and familiar people. They used a corpus of conversational telephone speech and analysed “turn-taking” which was defined as one side takes over before the other one finishes and “backchannel” which was defined as one interlocutor speaks in the middle of the other one’s turn. In total, Yuan et al. (2007) analysed 163 recordings with five minute-data, taken from minute three to minute eight. The authors did not explicitly say what the stranger/ familiar recording ratio has been. They also did not report the age or the number of subjects. Whilst the topics for conversation were aligned for strangers, familiar partners were able to choose a topic for discussion. The recordings were segmented using the intensity curve in a spectrogram as criteria to mark speech and the time of the overlap tokens where both sides were speaking was assessed. The analysis showed that women’s speech was more likely to be overlapped than men’s speech and that women slightly tend to initiate more overlaps when talking to men than vice versa. This outcome is consistent for each condition (familiar and stranger). Further, when talking to strangers, interlocutors used fewer overlaps than familiar partners. They also looked at the correlation between the conversation sides and wanted to know: if one partner makes frequent overlaps, does the other one too? The results showed that the “turn-taking” type had a higher correlation than the “backchannel” type. In other words, if one partner initiated more “turn-taking” overlaps, so did the interlocutor. Yuan et al. (2007) interpreted this outcome as an accommodation to the partner’s conversational style, whilst the lesser correlation between the “backchannel” type was explained through its nature of asymmetry in conversations. Though the authors of this study eliminated recordings with poor quality, it cannot be assumed that the telephone partners interrupted each because of difficulties with the transmission quality. Due to the experiment design, the authors missed the opportunity to analyse the role behaviour (lead and non-lead) between strangers and friends.

In an earlier study, Yuan et al. (2006) were using the same corpora, but different transcripts (2438 recordings). They considered the entire conversations for their analysis which focussed on the speaking rate as a function of turn length. For familiar speakers, Yuan et al. (2006) analysed 943,044 segments and for the unfamiliar speakers 248,479 segments. A segment length was defined as the number of words in a segment. The speaking rate was computed by considering words per minute depending on the segment length. They found that strangers used longer segments but showed a slower speaking rate than familiar interlocutors. They explained this unexpected pattern with politeness and an increased formality between strangers. They also considered that shared knowledge between familiar partners permitted a higher speaking rate with shorter segment lengths. In this study, they analysed the influence of age of the speakers; older people tend to have a slower speaking rate but produced statistical significant more variation in segment length than younger subjects did. A controversial discussion about the method may arise, if the design is examined; whilst the familiar partners were able to choose any topic to be discussed, strangers discussed aligned topics. The authors analysed the effect of conversation topic on the speaking rate, but it is debatable if a comparison of these two different experimental designs is meaningful as it is only of limited information. Spontaneous speech has a different construct than a biased conversation development and comparing familiar and unfamiliar conversational behaviour does not seem to be reliable for drawing any conclusion for a Familiarity effect.

A key role in the study of conversations is the occurrence of the notion of a dialogue act, "in particular […] the interpretation of the behaviour of dialogue participants and […] the design of spoken dialogue systems" ((Bunt, 2011), p.1). We will extend the research about the Familiarity effect on to the coordination of conversation from another point of view:

In the study of Cassell et al. (2007), knowledge coordination (turn-taking and adjacency pairs) and interpersonal (social) coordination (mutual understanding) between friends and strangers were under examination. A direction-giving task where half of the participants could see each other and the other half of subjects was divided by a screen was used. Eight conversations from 16 subjects were recorded. The experimenter accompanied and showed the direction-giver a route from one location in a building to another without providing a map. Afterwards was the direction-receiver told to ask the giver as many questions as needed to follow the directions and finally to find the location. The givers were always familiar with the building, but the direction-receivers were not. The task was repeated three times to consider the progress of mutual understanding. Conversations were coded with time-aligned transcriptions to analyse the following dialogue acts "Acknowledgments, Answers, Assert, Completion, Influence, Information Request, Reassert, Repeat-Rephrase, Signal Non Understanding" as well as "Looking at eyes, eye region, face and Head nod". First, they have found that friends used a significantly greater number of turns per minute than strangers; friends were more likely to intervene in the direction giving than were strangers. However, friends needed less time to finish the task. Cassell et al. (2007) found a significant difference in the means for the length of the three routes in seconds: whilst route 1 was finished in 165 seconds, route 2 and 3 were completed in 395 seconds (2) and 387 seconds (3). A possible statistical differentiation between friends and strangers were not given. The measurements for Acknowledgements and Look at Speaker and Head nod were reported in detail. Regarding the verbal behaviour, a difference for the relationship was only found for direction-receivers: receiver strangers used more Acknowledgements than receiver friends. No differences for the parameters mentioned above were found for giver friends and giver strangers. The authors did not provide any statistical evidence for these statements. The visibility of the interlocutors showed a significant difference in the means of Acknowledgments between friends and strangers if the subjects could see each other during the instruction performance. The non-visibility condition failed to show statistical differences for the means of the number of Acknowledgments between strangers and friends.

Taking the non-behavioural measurements into account in order to get information about the knowledge coordination, among strangers, the receiver's Acknowledgments were strongly associated with gaze patterns; the giver looks at the receiver to signal the need for feedback, the receiver provides feedback by acknowledging the giver's speech and then looks back at the giver. This pattern was also observed vice-versa and more frequently used by strangers than by friends. The authors did not interpret this behaviour as mutual understanding, but as an indicator for showing attention (Cassell et al., 2007). The increased use of Acknowledgment lets to an increased length of the conversation (friends: 847 seconds, strangers: 1049 seconds). The length of the strangers' dialogues showed a more effortful interaction and "may demand additional cognitive resources for Strangers, with the Receiver in Strangers dialogues breaking gaze at the Giver to apparently consult some internal representation of the space just described at the Givers Assert […], before returning attention, and gaze, once again to the Giver" ((Cassell et al., 2007), p.47). Friends' dialogues used fewer dialogue acts mentioned above as there was little need to negotiate understanding. According to the author, this is grounded on some sort of shared representation which requires less mutual gaze. In the friends' dialogues, the receiver's direct gaze, e.g. whilst the giver use an Influence dialogue act ("turn left"), and the reduced number of e.g. Acknowledgments may indicate that friends are less concerned about a lack of nonverbal feedback which may lead to a conversational breakdown or awkwardness.

However, both, strangers and friends increased the use of gaze from route 1 to route 2. The authors found better coordination not by relation progress, but through fewer coordination devices and fewer dialogue acts in each turn comparing routes and comparing friends and strangers.

The authors finally observed that no statistical difference between strangers and friends dialogues was found if the advantage of interpersonal knowledge was taken away under the non-visibility condition.

Cassell et al. (2007) were especially surprised by the outcome that the prediction of a greater coordination as the relation progresses failed. However, the result may have been more conclusive if they would have taken percentages of the number of dialogue acts into account rather than computing with a function of the length of the route of the dyad's data (visible versus nonvisible) in seconds.

So far, we have described the influence of a Familiarity effect in healthy speech. As research about a Familiarity effect in dementia speech is rare, we will have to look at other similar diseases in order to build any expectations for a possible Familiarity effect in AD and FTD.
Most dementia patients suffer from depression at a certain stage of the disease. FTD patients frequently even get diagnosed wrongly with depression before being diagnosed with dementia. Therefore, we will focus on a study of depression and verbal behaviour in conversations with friends and strangers from Segrin and Flora (1998). They recruited 33 men and 41 women (students) with a mean age of 21.51, (StDev: 3.9), all diagnosed with depression. One half of the group were recorded with close friends, whereas the other half was paired randomly with a stranger to the participant. All subjects were instructed to discuss the "events of the day" within seven minutes, but could also discuss any other topic ((Segrin and Flora, 1998), p. 494). The recordings were transcribed and segmented into utterances (expressions of complete thoughts). Two coders disagreed in only 5% regarding the number of utterances. Segrin and Flora (1998) measured speech productivity (total number of utterances, number of completed utterances, number of words), disfluent speech productivity (number of abandoned utterances, interrupted utterances, incomplete utterances). Further, utterances were classified into one of nine categories taken from the Verbal Response Mode coding system (Stiles, 1978): disclosure, advisement, edification, confirmation, question, acknowledgment, interpretation, reflection and uncodable ((Segrin and Flora, 1998), p. 495). They also analysed basic skills in communication and problem solving within a couple. Positive (e.g. self-disclosure, acceptance of each other), neutral (e.g. metacommunication) and negative (e.g. disagreement, criticize) codes provided content for these measurements. The results showed no statistical difference between people with depression and those without, regarding speech productivity, dysfluent speech, positive and negative speech as well as self-focussed speech. The verbal behaviour of participants with the diagnosis of depression was distinguishable from non-depressed people when they communicated with friends.
The authors found a significant interaction of depression and relationship. Utterances that required assumptions about the experience of the other, were made more frequently by subjects with depression than by non-depressed participants. All participants increased this type of utterance with their friends compared to with strangers. Further, all participants made more positive utterances to strangers than to friends. However, in depressed-friend communication

negatively toned utterances were frequent. They concluded that people with and without depression used the same number of negative language statements but people with depression showed an increase in tendency to negatively toned speech if they were with intimates. As Segrin and Flora (1998) did not find a significant difference between depressed and non-depressed subjects in terms of speech productivity, they assumed that social skills of people with depression do not permeate all aspects of their social interactions. They raised concerns about the lack of analysis about non-verbal behaviour in their study which may uncover distress, at least with strangers “where adherence to social norms and display rules are more salient” ((Segrin and Flora, 1998), p. 501). They also raised awareness of the challenge of defining “friend” relationships and its effect on the conversational architecture and topics. Finally, they noted that the location of the experiment, a research laboratory, may have covered certain extreme behaviours or they were less likely to occur.

In agreement, Mikesell (2009) said that “the clinic provides structure that may minimize the expression of disturbed behaviour” in FTD, too (((Mikesell, 2009), p.136). She further argued that within the doctor-patient question-answer communication, limitation of features such as initiation of talk or awareness of the contextual cues might be unnoticed. In her study, she looked at the conversational behaviour between an SD patient (70 years) and his hired caretaker, a student researcher and his spouse. All recordings were collected in SD’s home by the student within a time period of six months (six hours of video-taped data) and were of every day events. Though the student may have been a stranger to SD, s/he became familiar over the time as s/he spent 50 hours with SD and his family. It was not clear at what time the recordings that were presented took place. Mikesell (2009) first analysed the conversational practices of SD and his limitations (e.g. he initiated little conversation, he gave minimal responses, even when inappropriate), without differentiating directly between SD’s conversational behaviour towards his interlocutors. She continued by analysing the conversational practices of SD’s interlocutors, but she did not mention if a certain practice was typical for one specific partner or if the conversational behaviour was a general practice for the interaction with SD (e.g. redoing questions, yes/ no-type interrogatives to constrain their questions grammatically). However, it was observed that the student, who had less contact with SD, was causing more confusion by increasing the number of questions and repairs due to his lack of knowledge about SD’s past and circumstances. The author finally noted that the SD patient used some practices on which he could rely to stay in common ordinary conversations (using short or isolated sequences). SD showed difficulties in speech within larger sequences which led to specific strategies of SD’s interlocutors to enable him to participate further in the conversation. However, SD’s conversational partners did adjust to SD’s conversational competence to keep him included and to build him a frame to give the opportunity to successfully respond ((Mikesell, 2009), p.159).

Considering the literature presented above, depending on the experiment design and the parameters used, a Familiarity effect was found for language tone, speaking rate, number and length of turns and number of overlaps.
Based on the discussion about the influence of friends and strangers on to conversational behaviour and the lack of research in dementia, we define our second research question:

2. “Does the conversational behaviour differ between familiar and unfamiliar interlocutors with dementia?”
We will consider the Familiarity effect in our project as we think, that organization and planning of speech will decrease in the progress of dementia and we will try to find evidence that this effect might be a good feature to describe and characterise the subgroups.

In this chapter, we showed that each subgroup of dementia has its own limitations regarding speech and conversational behaviour. The abovementioned research groups evaluated conversational interaction by using quantitative as well as qualitative analyses and methodologies. Further, we found some evidence for a Familiarity effect in dementia.
Based on the literature mentioned above and our research interests, we continue to establish a methodology in order to describe AD, SD, PNFA and bvFTD regarding their conversational behaviour.

Chapter 3 Conversation Analysis - A Review

A suitable method for researching conversation in healthy and pathological speech (Adams and Bishop, 1989; Ferguson, 1998; Ripich et al., 1991) might be Conversation Analysis (CA) and specifically, turn-taking analysis which includes all the features tested in the experiments above.

Basic knowledge about CA and turn-taking features as well as an introduction to overlapping talk will be the content of this section. The focus will be on linguistic and phonological aspects of speech and natural conversation. At the end of this chapter, we will define our third research question.

3.1 Concept of CA

Conversation analysis focuses on meaning and the constructive function of speech by detailing its interactional processes (Avdi, 2008). In the first instance, CA aims to describe the underlying social organization in speech such as the institutionalisation or the consolidation of interactional rules, procedures and conventions to target the goal intended by the activity (Goodwin and Heritage, 1990). The concept of CA is to analyse the whole construct of communication rather than utterances and sentences in isolation. Goodwin & Heritage (1990) define the CA framework as follows: "[...] it describes a procedure through which participants constrain one another, and hold one another accountable, to produce coherent and intelligible courses of action." The ability of a conversation participant to analyse past speech events in order to predict the upcoming event carries the continuity of the talk. CA explores how participants analyse and interpret each other's actions and how they emerge a common understanding of their interaction (Seedhouse, 2004).
According to Seedhouse (2004) the essential question at all stages of CA is about: why that, in that way, right now?
The interactional organization of conversations is based on four different but related types.

<u>Adjacency pairs</u>
First, the concept of adjacency pair (Cooren and Fairhurst, 2004; Goodwin and Heritage, 1990; Seedhouse, 2004). Its function can be described as a reciprocal interaction between two events. The first pair part, such as a greeting, requires a production of the second pair part after the first is completed. Both parts become conditionally relevant. The template of the adjacency pair allows also an analysis of the previous turn and gives room for interpretation, which proceeds into the next turn. Sequences or the order of actions, such as question-answer adjacency pair, occur not

only in a linear fashion or in a serial order. The following example is taken from Seedhouse (2004):

1. A: can I have a bottle of Mich?	Q1
2. B: are you over twenty-one?	Q2
3. A: no.	A2
4. B: no.	A1

The adjacency pair does not require that the second part is always provided for the first part. The concept is more a "[...] normative frame of reference, which provides a framework for understanding actions and providing accountability." ((Seedhouse, 2004), p.18). This is the case when a question is not immediately answered (absent) and the question has to be repeated (accountable).

Preference

The notion of preference or preference organization is another type of interactional organization and is the construct for the organization of the adjacency pair. CA may also reveal structural preferences for sequences. The preferences issue, for example, affiliation (preferred action) and disaffiliation (dispreferred action) in a certain social situation. Goodwin & Herritage (1990) give a classroom scenario as an example. This scenario was composed of a teacher's corrections to students' classroom errors. They observed that during the teacher-student interaction, disaffiliative actions were prefaced, delayed and/or migitated in comparison to their affiliative counterparts. The authors monitored further that disagreements were normally prefaced (or marked) by silence whereas an agreement was produced immediately and promptly (affiliative action).

In the context of preference, the consideration of presequences is relevant as well. Presequences are pairs which act as a preparation for an up-coming pair, such as requests, jokes, news announcement and invitations (Goodwin and Heritage, 1990). Seedhouse (2004) gives the following example:

1. A: whatcha doin?
2. B: nothin'
3. A: wanna drink?

The first question is used as a preliminary sequence which has the aim of determining if B is able to accept an invitation. The question is then used as the first pair.

Finally, turn-taking and repair are parts of the CA as well. The term turn constructional unit (TCU) will play an important role in describing the underlying structure of the turn organization. Margaret (Selting (2000) defines a TCU as a unit which is held for turn-taking: it is a “potentially complete turn”. Following the explanation of Schegloff (1996), TCUs are built by grammatical structuring and fitting to the organizational demand of turns as the “host space” in which language deposits are accommodated. TCUs are used to find organizational devices for units from which turns are constructed. “A TCU can be understand as a single social action which is performed in a turn or a sequence” ((Seedhouse, 2004), p.30). Units can be one or more sentences, clauses, words and lexical constructions and describe an entire turn.
Moreover, a TCU can be performed non-verbally. It is a social concept (more than linguistic) and comprises three sequential efforts in terms of past, present and future items (Seedhouse, 2004). In short, a TCU builds the construct for a turn that fits to a past sequence, is appropriate to suit a social action in the present and provides a context for an upcoming turn. Sacks et al. (1974) give an example in which the first sentence relates to a prior turn (past) and the following question projects a next turn (future):

1. D: Jude loves olives.
2. J: That’s not bad.
3. D: She eats them all the time. I understand they’re fattening, huh?

((Sacks et al., 1974), p.722)

The projectable end of the TCU is known as the transition relevance place (TRP): when a speaker is going to finish a turn, the listener projects a point at which a speaker change may occur. A transfer of speakership is then coordinated through the TRP and any unit-type (TCU) instance will finally achieve this place and may indicate a turn-taking (Sacks et al., 1974).
To sum up, TCUs (e.g. syntactic constructions such as sentences, lexical constructions, clauses, one word, intonation) allow projections of possible completions or TRP.

<u>Repair</u>

The initiation of a repair is caused by a trouble occurring in interactive language use. Repair mechanisms exist for dealing with errors and violation during a conversation, e.g. if two participants are talking at the same time, one will stop talking to repair the trouble.
However, it should be mentioned that Schegloff (1996) considered the term repair not only as an initiation to solve an occurring trouble, but also as a pre-possible completion. In other words, if a self-repair is initiated at a possible TCU before the final TCU is achieved, then this position is called pre-possible completion. Schegloff (1996) gives this example to provide evidence:

Curt: He- he’s about the only regular <he’s about the only good regular out there’z, Keegan still go out?[2]

The relevant point here is that the self-repair is initiated because the speaker wants to insert “good”. The self-repair starts, following the author, before the possible completion in the final delivery of the TCU ’out’. Within the CA, self-initiated repair (the speaker repairs promptly his own mistake) is distinguished from other-initiated repair (the interlocutor notices the speaker’s mistake and initiates a repair). Further, self-repair (the speaker corrects himself) should be considered separately from other-repair (the interlocutor corrects the speaker’s mistake). Seedhouse (2004) points out that there is a clear preference structure in the organization of repair. The most preferred one is the self-initiated self-repair in contrast to the other-initiated other repair which is least preferred. This preference structure is not a rule that participants have to use in a conversation, it is an action template, which allows them to display their level of affiliation to each other and to interpret their actions.

<u>Turn-Taking</u>

Turn-taking is an additional subtype of interactional organization and the main parameter used in this research. In their influential analysis, Sacks et al. (1974) described the organization of turn-taking for conversation and paved the way for future research concerning TCU, which are nowadays used for CA. The aim of their research was to show that turn-taking organization has two important underlying features:

1. It is context-free
2. It is capable of extraordinary context-sensitivity.

According to the authors, in conversations techniques exist which allow turn allocation. First, a technique in which the speaker initiates the next turn by selecting the next speaker and second, a technique in which a next turn is allocated by self-selection. An example: Ben and Bill’s turns are obviously allocated by Sara (selecting next), further, Sara initiates her turn by herself (self-selection):

[2] < marks a slightly early start of the bit of talk which follows it. ’z: reduction of the first word of what follows to its last sound (’does’).

1. Sara: Ben you want some ( )?

2. Ben: Well alright I'll have a, ((pause))

3. Sara: Bill you want some?

4. Bill: No.

((Sacks et al., 1974), p.703)

Less than 5% of speech is delivered with overlap: gaps between the conversational participants are usually measured in tenth of seconds (Seedhouse, 2004). The system for turn-taking must be robust and following this consideration, some rules must exist. Rules concerning turn-taking have the aim of minimizing gaps and violations in conversation, but they also provide a construct for the allocation of a next turn.

1. if the turn is, at the TRP, so constructed that the current speaker can use select-next technique, then the interlocutor is obliged (Kurtić et al., 2013) and has the right to take the next turn. No other participant has this right
2. in case the turn-so-far is constructed that the current speaker does not use the select- next technique, the upcoming speaker may consider a self-selection technique. The first to start acquires the right for the next turn and a transfer takes place
3. if the turn-so-far is constructed such that the current speaker does not pick up the select-next technique, then the current speaker may, but need not continue, except another speaker self-selects
4. if at the initial TRP of an initial TCU neither 1. or 2. was chosen and following rule 3., the current speaker has continued, then the rules 1.-3. reapply at the next TRP and so on, until the transfer is effected (Sacks et al., 1974). The aforementioned turn allocation techniques (next-/ self-selection by the current speaker) are compatible with this set of rules and clearly give an explanation of 'one speaker at a time' and for the violation potential if the rules are not ordered or kept. In reference to the robust turn-taking system mentioned by Seedhouse (2004), the rule-set eliminates through its constraints the gap and the overlap from most of the conversation "[...] by eliminating gap and overlap from most single turns."

The work of Ford and Thompson (1996) provided an overview about possible measurement for TCUs and TRPs and how important these parameters are for turn-taking organization. They approached classification of basic linguistic units used by speakers in spontaneous communication. They noted syntax, intonation and pragmatics as core features for managing turns. They used data from two face-to-face, multiparty conversations in American English with about 20 minutes of talk. Their central questions were:

- is syntactic completion a predictor of turn completion as validated by the speaker?;
- are crucial interactional factors at work for speaker change (in the absence of convergence of syntactic, intonational and pragmatic completion)?

The authors examined the data under the condition of syntactic, intonational and pragmatic completion.

Under syntactic completion, they evaluated "[...] an utterance to be syntactically complete if, in its discourse context, it could be interpreted as a complete clause, that is, with an overt or directly recoverable predicate, without considering intonation or interactional import." ((Ford and Thompson, 1996), p.143). In addition, elliptical clauses, answers to questions and backchannel responses were included in the analysis.

Intonational completion was defined as a prosodic unit (starting point) or intonation unit. The authors decided to take the intonation unit as an established auditory unit (perceptual) and marked the unit ends in the transcript only when they detected exhibited features of finality in meaning of a point with clear final intonation indicated by a period or question mark (final vs. non-final contours). [Ford and Thompson (1996) also indicate acoustic correlates by producing pitch traces.]

Pragmatic completion was noted as "[...] an utterance was required to have a final intonation contour and had to be interpretable as a complete conversational action within its specific sequential context" ((Ford and Thompson, 1996), p.150). Furthermore, the authors divided pragmatic completion in two groups.
First, they introduced the term local completion. Local pragmatic completions were defined as points at which the speaker was projecting more talk, but at which another talker might reasonably take a minimal turn (small, non-floor-taking turn). Global completion which included "[...] the property of not projecting anything beyond itself in the way of a longer story, account, or another agenda" ((Ford and Thompson, 1996), p.151) was considered as the other part of the pragmatic completion. Pragmatic completion was understood as a combination of intonation and conversational action sequencing.

Finally, speaker change was taken into account in turn-taking analyses. This point was judged on where another speaker took an obvious turn (full turn or backchannel turn). Ford and Thompson defined types of backchannel responses as continuers, displays of interest, claims of understanding, collaboration finishes and help with word findings. As a result, the authors found out that initiating a turn-taking depends on several subtle features. The three types (syntactic, intonational and pragmatic cues) converged to a great extent and defined TRPs. The authors figured out that intonation played a major role when the speaker wanted to set a signal for a turn-taking.

They also showed that people recognize an intended turn-taking whilst the speaker is still in the midst of a unit.

The authors concluded that interlocutors must be able to project the next upcoming turn-taking in order to use strategies for overlap or early turn initiation.

3.2 Overlapping Talk

The phenomenon of beginning a turn with an overlap will be under examination in this study. As we have presented in Chapter 2.4, a Familiarity effect was found for language tone, speaking rate, number and length of turns and number of overlaps. We chose the number of overlaps as measurement and indicator for this study for analysing the conversational behaviour of healthy, AD and FTD speech as we wished to explore a possible Familiarity effect.

We decided to focus on overlaps in speech due to the well-known delay in dementia speech occurring for several reasons such as the decline of working memory or slower progression of discourse (Blanken et al., 1987; Jones et al., 2016) which may result in an increased number of late initiated turn-taking and overlaps.

As we developed our parameters within the already existing types of overlaps, we will outline a description of overlap types and their occurrence in conversations based on the literature.

One of the first CA studies concentrating on overlapping talk was conducted by Gail Jefferson (Jefferson, 1984). Her main research interest was located in the place (onset) of overlap occurrence. She focussed on three distinctive “types” of overlap onsets:

1. Transitional onset: this type of overlap onset begins at a point when a possible syntactic or utterance of turn completion is in progress whilst the current speaker is continuing his/her talk. The transitional overlap is divided in to

- Terminal onset: the next speaker starts at the final sound(s) of the last word of the current speaker’s turn
- Latched onset: the current speaker comes to the end of a turn without there being a pause before s/he initiates another turn. The next speaker comes in right at the end of the turn resulting in a simultaneous start of turns

- Unmarked next position onset: the current speaker just permits little space between the end of the turn and the new one. The next speaker begins to talk, but at that time, the previous speaker continues talking.

2. Recognitional onset: the next speaker orientates to adequacy rather than to completeness. This category is divided in to two subtypes

- Item-targeted onset: though a possible TRP has not been adequately achieved, a certain item was produced for recognition and response
- Thrust-projective onset: the next speaker starts before a TRP has been reached, "but where an understanding of at least the general thrust of the utterance can have been achieved" ((Jefferson, 1984), p. 30)

3. Progressional onset: the next speaker foresees a problem (e.g. disfluency or "hitches'") arising towards completion and acting upon it by starting a turn

A more recent investigation of overlapping talk was made by Schegloff (2000). He developed an "overlap resolution device" that suggests how participants deal with simultaneous talk and how the resolving strategies are organised in the turn-taking system described by Sacks et al. (1974). Schegloff (2000) examined the resources (hitches and perturbations), phases of overlaps and the interactive logic of deployment. Possible resolutions after an overlap occurred may be, for example withdrawal of one or both parties, longer or extended overlaps after competition, persistence to completion or to project the thrust of the turn. The author also addressed the "overlap aftermath" and described participants' strategies returning to a solo production (e.g. not treating the overlapping event at all, natural completion or addressing the speaker's utterance, then redoing one's own). He concluded that the "overlap resolution device" addresses the question of who is taking the turn after an overlap occurred as it is not necessarily the "first starter" who should succeed as suggested by Sacks et al. (1974).

A great interest in overlapping research is set on the competetive design of overlaps in turn-taking. We did not examine non-/competitiveness in turn-taking in our analysis directly, but as we were developing our parameters within competitive and non-competetive overlap types/categories, we will briefly introduce the competitiveness in overlapping talk.
Following the definition of Tran (2002), "turn-competitive overlaps are designed or received as competing for a turn at talk or for the right to hold the floor by that moment whereas turn-noncompetitive overlaps are not" ((Tran, 2002), p. 232).
According to Schegloff (2000), overlapping talk does not appear to be contesting if "the conduct of the participants does not show [overlap] occurrences to be taken as problematic by them" ((Schegloff, 2000), p. 4).

He divided non-competitive overlaps in to four categories:

1. Terminal overlaps:	One speaker is starting by anticipating a prior speaker's finishing his/her turn
2. Continuers:	Interpolations such as "mhm" and "huh" or context-fitted assessment terms. The listener understands what the speaker is saying and acknowledges his/her content
3. Conditional overlaps:	A speaker who has possibly not completed yet his/her turn invites another to speak in his/her turn's space. Schegloff noted that word search is the most familiar instance or when one speaker initiates an utterance and provides for the hearer to complete it
4. Choral overlaps:	Non-serial occurrences of turns that have to be taken simultaneously, such as laughter.

The different prosodic patterns in overlapping talk have been examined in the past as well in order to evaluate the resources of turn competition in overlapping talk, e.g. loudness, tempo, pitch and pause (French and Local, 1983; Kurtić et al., 2013; Tran, 2002; Wells and Macfarlane, 1998). In our study, we measured the F0 curve for deriving intonational completion points and identifying TRPs and TCUs easily. We also marked pauses. However, we did not analyse the prosodic and acoustic patterns for detecting competitiveness between turn-overlaps but rather using them for orientation regarding completion.

Turn-taking in dementia patients

The ability to use strategies of turn-taking, presumed to require the interpretation of several parameters such as facial expression or intonation (completion points (Ford and Thompson, 1996)), may become difficult for dementia patients, caused by their limited cognitive resources. An increase or decrease in the number of certain types of overlaps, as presented above, may be an indicator for limited abilities of discourse processing and conceptual preparation. Based on the concept of CA and turn-taking structures, especially considering the overlap types and the speech impairments in AD and FTD regarding conversational behaviour, we defined our third research questions as followed:

3. "Does the number of overlaps in conversations change during the progress of the disease?"
No study to date offers parameters derived from conversational interaction that can characterise and differentiate all four subgroups of the disease and there has therefore been no longitudinal study of changes to conversation interactions reported in the literature.

Observing overlapping behaviour is a new approach to analysing speech in dementia and has previously not been considered.

Chapter 4 Summary of Research Questions and Proposals

In this Chapter, we will briefly summarise the literature findings and embed the research questions in order to continue with our concept of analysis and the experimental design.
In the following, we do not keep the order of our three research questions, rephrased as proposals in this Chapter, as previously developed in Chapter 2 and 3, presenting our arguments in a logical top-down structure.

We propose that

1. the different types of dementia can be characterised by their speech behaviour in conversation.

We believe, based on the evidence in the literature, that speech and language observations will be useful in the early stage of diagnosis and for disease progression monitoring. It has already been shown in the literature that the FTD subgroups differ in discourse processing in several parameters (Peelle and Grossman, 2008). However, studies about CA and narrative abilities in dementia speech are rare, and in particular longitudinal observations have not been carried out. Turn-taking behaviour is not described in detail in the literature, though it is mentioned as a crucial factor to characterize the speech of dementia patients by some authors (Mikesell, 2009; Sabat, 1991; Watson, 1999).

We suggest that the turn-taking features found in natural conversation will permit differentiation or characterisation of subgroups of dementia at an early stage of the disease. We believe that there will be an increase in difficulties with organization and planning of speech during the progress of dementia.

2. Therefore we propose that the organization of turn-taking, defined here as the occurrence of overlaps, may cost more effort and result in different speech behaviour than the patient previously usually used.

We further propose that

3. turn-taking characteristics, here the occurrence of overlaps, will be different between conversations with familiar and unfamiliar conversation partners.

In the literature it is stated that for healthy subjects, difference concerning familiarity of conversation partner has no effect on the rate of disfluency or on the frequency of violation of turn-taking rules (Bortfeld et al., 2001; Branigan et al., 1999). However, planning of speech or organization of turn-taking might be processed very quickly. This skill could lead to the same disfluency rate in healthy speech with familiar and unfamiliar people. We, though, expect a Familiarity effect in dementia speech. It is shown in the literature that in a clinical environment, patients tend to cover their speech difficulties with a less familiar person (e.g. GP) (Cohen and Conway, 2007). Relatives often report that the patient is quite normal in the clinic but different otherwise (Mikesell, 2009). We propose that this behaviour may result in a more disfluent speech with a familiar person than with a less familiar person.

The possibility of an effect of Familiarity with the conversation partner in dementia groups on speech and language patterns, especially in FTD, has not been fully explored. It has been noted that social interaction should be included in a conversational approach (Clare and Shakespeare, 2004), but research literature in the context of AD and FTD diagnosis is limited. The exploration of the effect of Familiarity with the conversation partner in FTD and AD could, however, be useful for a characterisation of the speech patterns of those groups and could therefore be advantageous to consider when developing criteria for diagnosis and monitoring. Additionally, appropriate guidelines could help to improve inter speaker attitudes and reduce distress in conversation especially between the patient and a familiar person, independent of dementia groups.

In this chapter, we have outlined our research proposals based on literature findings in a reliable and consistent presentation. We continue with a description of the methodology used in this study to address the abovementioned proposals and research questions.

Chapter 5 Methodology

This research comprised two studies: a healthy study and a patient study. The patient study includes results derived from conversation recordings from AD and FTD patients.

We first performed the healthy study in order to evaluate normal conversational behaviour regarding overlap in speech, the suitability of the chosen measurements (categories) and a possible Familiarity effect.
We next carried out a patient study, using the same categories and focussing on AD patients to assess conversational behaviour regarding overlaps and also considering a Familiarity effect. We continued by analysing the FTD data and conducted a case study for each FTD subtype (SD, PNFA and bvFTD).

5.1 Ethics

Working with human participants, especially with vulnerable patients such as dementia patients, requires permission for research.
The healthy study was given ethical approval by the University of Southampton Ethics and Research Governance, Dept. of the Faculty of Engineering and the Environment, (reference number 8316) with study title: Conversation Analysis and Turn-Taking Behaviour. All documents submitted for the approval process can be found in appendix B.
The patient study was approved by the University of Southampton Ethics and Research Governance, Dept. of the Faculty of Engineering and the Environment, under the title: Turn-taking during conversational interaction in Alzheimer's disease and frontotemporal dementia (reference number: 6906) (appendix C and D (insurance letter)) and by the NHS (NRES Committee London), registered under 13/LO/1301, project ID: 124708 with the title: Turn-taking during conversational interaction in Alzheimer's disease and frontotemporal dementia (appendix E).

This project is further registered at St. George's Hospital in London, which hosts the site under 14.0013 (appendix F).

We made a minor variation to the approved protocol in that patients took the Non-lead role in the speech task only. Further information will be provided in the following section and chapters. Initially we assigned the leading role to the patient, but as our first patient was not capable of performing as the Lead in the speech task, based on stress and insecurity, we decided to change the performing role for all future patients.

5.2 Experiment design

In the following section, an outline of the methods will be presented, starting with a brief overview, then defining criteria for participation, followed by an explanation of the speech task itself. A short outline of the very similar experimental procedure for the healthy study will be presented afterwards.
Finally, parameters to be considered will be given.

1. Patient study

Study design
This was a longitudinal study with patients and their carers taking part in a session at intervals of approximately 6-9 months over a period of 14 months. Each session lasted for a maximum of 70 minutes. All participants were audio- and video recorded while taking part in an undirected spontaneous dialogue elicited using a standardised task protocol, administered at the end of a routine follow-up visit to the cognitive neurology clinic where their condition is clinically monitored and managed.
Informed consent was obtained from patients and their carers before each recording session. Eligible participants were patients for whom a diagnosis of AD or FTD has been made, and their carers. It was necessary for inclusion that both the patient and their carer consented to take part in the study.
The patients were recorded during performance of the conversation task with the carer, and with a less familiar person (in this case a student or research assistant). Additionally, the carers were asked to complete a questionnaire on each occasion about speech and language changes they had observed in the patient.

Participants
Patients with AD, PNFA, SD or bvFTD diagnosis, made within the previous two years by a neurologist, who are able to understand the nature and purpose of the study and consent to participate are eligible. The patients' regular carers were the interlocutors and therefore part of this study. Their carer was asked to give consent for their own participation.
It is important to note that we had access to pre-existing clinic evaluations such as the result of the ACE-R and other relevant medical and personal information for the study.
We defined the following inclusion and exclusion criteria for both, patient and their partner:
Patients will be invited to participate if

1. they carry a diagnosis of AD, PNFA, SD or bvFTD, made by a neurologist
2. they are at a sufficiently early stage of disease at point of joining the study; up to 6 months

after diagnosis was chosen as the threshold for inclusion

3. they are willing and motivated to take part in the research

4. English is the normal language of conversation with their carer.

Carers should fulfil these criteria:

1. they should have a sufficiently close relationship to the patient (family member, regular carer) to be able to complete a questionnaire concerning changes to the patient's speech

2. they should be cognitively unimpaired and in good general health.

Exclusion criteria were defined as well and were valid for both patients and their partners:

1. any medication (e.g. sedative drugs such as Benzodiazepines), which may exert an adverse effect on attention or concentration to an extent that would be detrimental to performance of the task

2. no (additional) neurological brain impairment which influences speech behaviour (e.g. brain tumour).

Speech tasks

Two natural conversation dialogues between the participant and i) their partner and ii) a less familiar person, were audio- and video recorded over a time period of approximately 70 minutes at intervals of approximately 6 months over a 14 month period. We were not interested in the content of the conversation, but in the organization of conversational turn-taking and specifically overlapping speech.

Due to our experimental design (see below), one interlocutor is the direction-giver and the other one is the direction-receiver. In the patient study, we appointed the patients as direction-receivers. In the first session, the researcher noticed that the patient was uncertain about his ability of doing the speech task though he was capable of completing the task. To resolve the stress, the researcher decided to appoint the patient as the receiver. By doing so, the patient felt more comfortable as he could get familiar with the task whilst his partner initiated the conversation. This procedure was successful in terms of completion and decreasing the stress level. It was therefore continued for all other patient recordings.

Map task

A map task in which the direction-giver (carer or research assistant) describes to the direction-receiver (patient) how to get from a starting to a finishing point on the map was used. There were deliberate differences in the copies of the maps held by the two conversational partners, for example: whereas the patient can see a van in the bottom left corner of the map, the map for the carer has no van printed in the bottom left corner. Figure 5 shows one map in two different versions, one for the patient and one for his/her interlocutor:

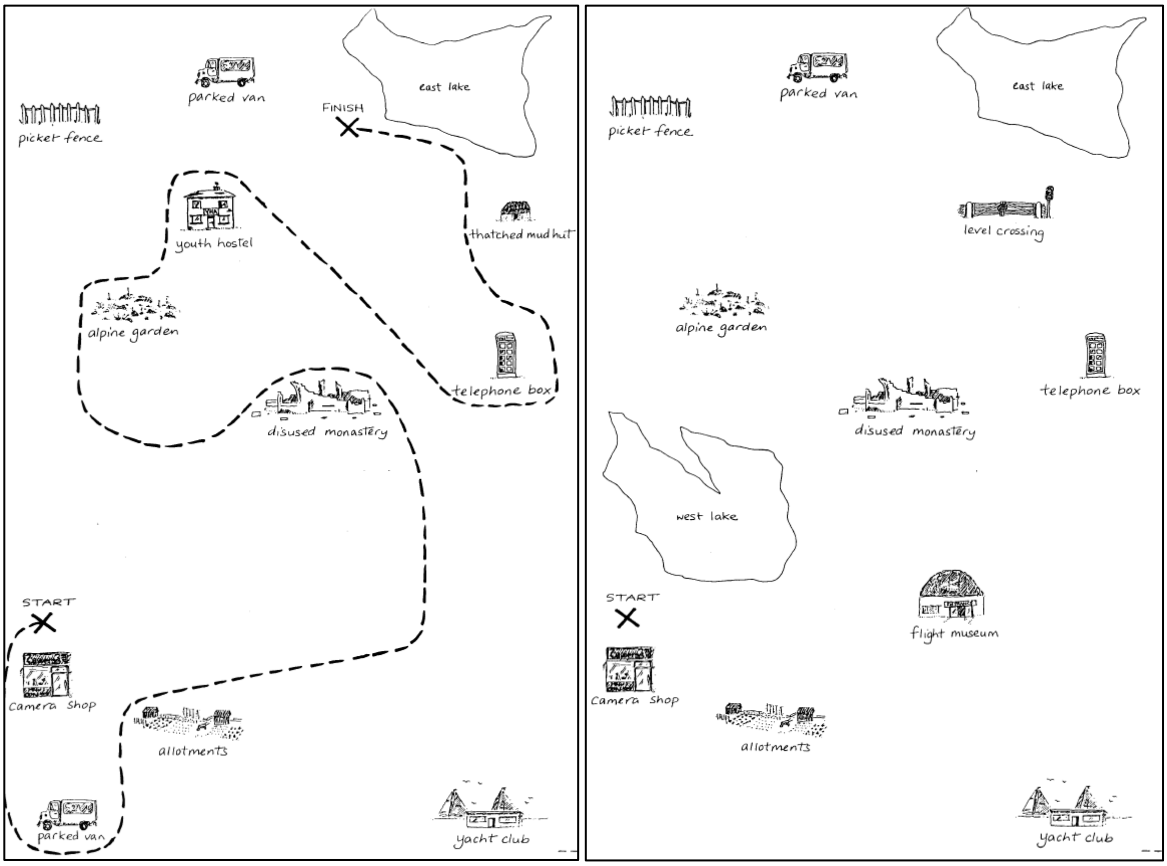

Figure 5 Examples of the speech task. Left map: Carer, right map: Patient

We decided to use the map task for evaluating data as it was successfully implemented in other speech and conversation studies as well, especially if a Familiarity effect is under examination. Heldner and Edlund (2010) claim that within the map task domain, it has been shown that (complex) speech tasks and (lack of) Familiarity result in “faster speaker changes to the extent that average switching times are negative (overlapping)“ (Heldner and Edlund, 2010).
According to Paggio and Vella (2013), the clear role division in the map Task corpus, gives rise to fewer overlaps than in an undirected conversation. However, they detected that the “amount of overlap increases as the dialogue proceeds, showing that the frequency of overlap is dependent on subjects’ familiarity with each other and with the situation. The importance of role assignment is also reflected in the fact that in the map task dialogues, the Leader mostly has the turn after an overlap involving a change of speaker” ((Paggio and Vella, 2013), p27). It should be mentioned that they analysed Maltese, but gave reliable overall information about the map task nevertheless. Further, the turn-taking system is similar to the structure of English (Gilbert et al., 2006) and therefore the results can be transferred.
The map task has been widely used to support study of spontaneous conversation in healthy speech, but also in speech and language disorders such as dysphasia (Merrison et al., 2005).

Dysphasia is often referred to aphasia, which actually implies a moderate form of the latter one. We outlined in Chapter 2.2 that dementia patients do show aphasic symptoms, too. Therefore, we considered the map task as a promising tool for being able to extract specific behaviour regarding overlap in conversations.

First speech task

After a 20 minute introduction in which the study background and procedure were explained, both participants were asked to sit face to face at a table. The patient chose one map randomly from the set of maps and gave the corresponding second map to their carer. The audio recording equipment, set on the table between the conversation partners, and the video recording equipment, set in the corners of the room, facing the two interlocutors, were turned on by the researcher to record the conversation for later processing. The researcher was not in the room during the conversation but was within earshot of the participants in case of any problems or questions arising. After the conversation was finished, the researcher switched off the recording equipment. The endpoint of the conversation was achieved either by finishing the task or by an indication of conversation running out such as long silence or call for the researcher to return. Following the speech task, a 10 minutes break was given in which the participants could move around, as they wished.

Second speech task

A second map task was used to record a conversation between the participant and a less familiar person, who was a student or research assistant. The patient chose randomly from the remaining set of maps and gave the corresponding second map to the student or research assistant. The procedure was the same as for the first task. The carer was not present but was within earshot of the participants in case of any problems or questions arising. After the conversation was finished, the recording device was switched off by the researcher. The endpoint of the conversation was either achieved by finishing the route or by an indication of conversation running out such as silence or a verbal indication from the patient to the researcher.

2. Healthy study

Study design

All participants were audio- and video recorded while taking part in an undirected spontaneous dialogue elicited using a standardised task protocol.

Informed consent was obtained from all participants before each recording session.

The subjects were recorded during performance of the conversation task with a friend, and with a less familiar person (in this case a student or researcher). Each recording lasted 10 minutes.

Participants

Candidates were be required to be 18 years of age or older, so as to be able to give consent. It was emphasized in the information sheet that participation was voluntary.

The inclusion criteria for participants were:

1. first language is English/ or fluent English speaker
2. participants must be over 18 years of age

We excluded subjects with self-reported hearing impairment or self-reported cognitive speech impairment (e.g. aphasia, dysphasia following brain injury).

Flyers with information about the project and contact details were posted mainly in the ISVR (Institute of Sound & Vibration, Building 13, Highfield Campus) to recruit students.

Speech task

The speech tasks which were performed were the same as we used for the patient study:

A map task in which the participant describes to a familiar and/or an unfamiliar person how to get from a starting to a finishing point on the map was used. There were deliberate differences in the copies of the maps held by the two conversational partners.

Both participants were asked to sit face to face on a table in a clinic room (ISVR). One participant chose one map from the provided set of maps randomly and gave the corresponding second map to their interlocutor. The audio recording equipment, set on the table between the conversation partners, and the video recording equipment, set in the corners of the room, were turned on by the researcher to record the conversation for later processing. The researcher was not in the room during the conversation but was within earshot of the conversation in case of any problems or questions arising. After the conversation was finished, the recording was ended by the researcher. The endpoint of the conversation was either achieved by finishing the route or by an indication of conversation running out such as silence or verbally note towards the researcher. Whenever possible, a second recording took place with either a familiar or an unfamiliar interlocutor afterwards or at another appointment.

5.3 Categories

CA techniques described below were used to mark the linguistic behaviour for each pair of participants. The changes in behaviour within each group over time were analysed in order to develop a profile of language change for the subject groups. We also considered the speech and language changes over time within individuals. The lack of literature concerning turn-taking analysis in dementia required us to adopt analysis measures which have been validated by several CA and turn-taking researchers for healthy and other kinds of impaired speech such as semantic-pragmatic disorder (Adams and Bishop, 1989; Cowley, 1998; Ford and Thompson, 1996), but not within our particular patient groups. We evaluated the applicability of these measures to dementia speech during the study and discuss their suitability for future use with these patient groups.

As we focus on conversational interaction and turn-taking in detail, we investigated here the event of break-downs; failures in the speech flow. Referring to our research proposal,

> We assume that different types of dementia can be characterised and differentiated from healthy speakers by their conversational behaviour regarding overlaps in speech.

In the context of turn-taking analysis, we predict that speech and language observations will be useful in the early stage of diagnosis and for disease progression monitoring.

We expect a Familiarity effect in dementia speech. It is shown in the literature that in a clinical environment, patients tend to mask their speech difficulties with a less familiar person (Chapters 2.4 and 4). We predict that turn-taking becomes more difficult for dementia patients in complex ways. Consequently, we are looking for occurrences in turn-taking which are difficult to solve in terms of keeping the conversation *as efficient as possible* when an error has been made by one or other of the participants. We define “conversational efficiency” as speech flow without interruption, solving a potential conversational break-down as soon as possible by any of the conversational participant and/or adapting to the current speaker's conversational behaviour.
We divide overlapping talk into six categories:

1. Confirmations:
We assessed attention and confidence in speech by counting the number of Overlaps of the category Confirmations (section 5.3.1).

2. Predictions:
We appointed the category Predictions to evaluate time management in conversations and grammatical and discourse processing abilities (section 5.3.2).

3. Full Turn-Taking:
As a third category, we used Full Turn-Taking overlaps as an indicator for hesitant or dominant behaviour in conversations leading to a successful turn taking (section 5.3.3).

4. Failed Turn-Taking:
Counting overlaps of the category Failed Turn-Taking was a measurement that demonstrated the extent of willingness to stop and abort an initiated overlap (section 5.3.4).

5. Failed Turn-Taking but utterance is Completed:
We assessed a Completed but Failed Turn-Taking in order to meet the requirements of considering a Failed Turn-Taking which was nonetheless successful in terms of finishing an overlap turn. We used intonational completion for aligning the number of Failed Turn-Taking Completed with our definition, presented in section 5.3.5.

6. Others:
The category Others was introduced as we found several overlaps which could not be individually categorised but which were meaningful to consider regarding our case studies and made a detailed analysis of certain behaviours, such as laughter (examples for "Others"-overlaps in section 5.3.6).

We further subdivided the categories Confirmations, Predictions, FTT, FaiTT and FaiTTC into two sections for our discussions. We did so to meet the challenges of dementia speech which has proven difficulties with planning and organisation of speech (Peelle and Grossman, 2008).
The categories Confirmations and Predictions give information about the ability of planning and executing intentions whilst the latter three referred to strategic conversational behaviour of how to perform the planned and intended overlaps in order to contribute to the speech flow and increase efficiency (fast finishing of the task).

The chosen categories were modelled within the 4 types of overlaps suggested by Schegloff (2000),

1. Terminal overlaps:	One speaker starts by anticipating a prior speaker finishing his/her turn
2. Continuers:	Interpolations such as "mhm" and "huh" or context-fitted assessment terms. The listener understands what the speaker is saying and acknowledges his/her content

3. Conditional overlaps: A speaker who has possibly not yet completed his/her turn invites another to speak in his/her turn's space. Schegloff noted that word search is the most familiar instance or when one speaker initiates an utterance and provides for the hearer to complete it
4. Choral overlaps: Non-serial occurrences of turns that have to be taken simultaneously, such as laughter,

but with an extended approach to meet the symptoms of the AD and FTD patients as will be described in the following sections.

It should be noted that we did not distinguish between the terms "overlap" and "interruption" as mentioned by Schegloff (2000) as we were not interested in "where" an overlap occurs, but in the question of "how many" (the frequency of overlaps) and "what type".
According to Zimmerman and West (1996), "overlap" is classified as an event where the speaker starts speaking shortly before the end the current speaker's turn and "interruption" is an occurrence where the speaker violates the current speaker's turn (speech). An "interruption" leads to a disorganisation of the current speaker's speech.
However, we only evaluated an overlap within a category without considering the overlap's position, except for the category Predictions. We defined the category Predictions as the ability to not only anticipate an upcoming TRP or TCU, but also to predict phrases and grammatical structures (e.g. questions, requests), we did not differentiate between "overlap" and "interruption" in the category of Predictions either. We did, however, differentiate "overlaps" and "interruptions" for the category Predictions within the case study analysis and for single examples. We consider the term "interruption" as a technical category of overlaps, following the definition of "interjacent" overlaps by (Drew, 2009); a speaker begins speaking whilst the current speaker cannot be close to a completion point of a turn.
As we had to consider certain cognitive limitations resulting e.g. in difficulties in time management (delayed turn-taking reaction), we took the view that the "overlap"/"interruption" difference would not have given any information about the underlying structure of speech in dementia.
In the following analysis, we used the term "overlap" for all incidents regarding overlapping of current speech.

Following (Ford and Thompson, 1996), the annotation symbols for the transcripts are:

/	Syntactic unit
. or ?	Intonational completion point
>	Pragmatic completion point (obtained information that is not actually present in the utterance or statement itself
< >	Indicate that the material within the brackets slows down the surrounding speech and does not have a (rising) intonation curve. Mainly used for variations of the editing term “ehm”
__	Stress
-	Abrupt withdraw
[	Overlap
(.)	Doubt of the transcriber regarding completion
(())	Description
:	Prolonging
(1.5)	Duration in s

All examples are extracts from our audio recordings derived from healthy participants.

5.3.1 Confirmations

Confirmations are defined as short feedback utterances. The term confirmation includes negotiations as well. Examples for this category are: “ah”, “okay”, “mhm”, “yes”, “right”, “no” and so on. Confirmations within the speech can be tolerated by the current speaker to avoid a conversational break-down.

A: Ya: / just before you get to the house (0.27) / [start heading northwards ((northwards: 98Hz, flat-410Hz-95Hz, flat)) /> You next then Me further (0.4)

B: [Ya ./> You more

Example 1

A: And then: / <ehm> (0.26) / east cross the water ((water: 105Hz-477Hz)) / [so I'm guessing

B: [Ya ./> You more

A: [there's your bridge there /> You next then Me further

B: [Yes that's my bridge / ya ya ((ya: 227Hz-180Hz, flat)) / (no pause)

A: ((Short laughter)) (1.18) /

Example 2

A: <Ehm> (0.75) / tz (0.75) / a sort of follow the coast around / but before you`ll get to the end there is a th- there is a Well on the corner / so I have to sort [of curve that around

B: [Okay /

A: [it ((it: 118Hz-138Hz)) /> You next then Me further

B: [Okay ya: / so you're leaving the Well on the seaside ((seaside: 207Hz-80Hz)) ?/> You next

Example 3

In the first example, B confirms that s/he understood the description of speaker A and that s/he sees a house on the map, too. B's decision to give a confirmation could be a result of the pause A made. It can also be interpreted as a *You more* signal within an on-going utterance. Sacks et al. (1974, p.706) noted that: "Occurrences of more than one speaker at a time are common, but brief."

The second example is of a similar structure. B wants to confirm that s/he can follow A's description. B's confirmation has an intonational completion point intending a *You more* signal. B could have also assumed that A's speech has come to its finishing point and taken the turn quickly without any time loss. B's second attempt to interrupt A's speech with a confirmation ("yes") would support this assumption. By using the second confirmation shortly after the first one ("yah"), B signals that s/he is able to predict the completion point and selects him/herself as the next speaker (*Me next* signal): In this case by anticipating the object "Bridge".

Anticipation is the chosen strategy of B in example 3 as well. B predicts the end of a turn, using a confirmation to signal to A that s/he can process the given information successfully. However, A decides to finish his/her turn and sends a *Me further* signal, by increasing the pitch contour from 118 Hz to 138 Hz. This turn holding behaviour from A allows B to confirm, but does not necessarily mean that A wants to give the turn completely away. The following conversation proves this correct; B tries to take the turn before A finishes which results in an overlap. A breakdown does not occur, because B predicts the completion almost in time and continues with his/her speech fluently.

5.3.2 Predictions

The definition of an overlap caused by prediction is based on Sacks et al.'s (1974, p. 707) statement: "Variation in the articulation of the projected last part of a projectably last component of a turn's talk, which is in fact a consequential locus of articulatory variation, will expectably produce overlap between a current turn and a next".

A: And then as soon as you go pass the Gorillas / o:r I guess the [Banana Tree /
B: [Banana Tree / ya ./> You next

Example 4

A: So north west [to the Fallen [Pillars ?/> You next
B: [((Murmur)) / [Ya / eleven o'clock of the north of the Fallen Pillars /

Example 5

A: Can you see any Gazelles ((gazelles: 135Hz-90Hz-increase)) /> You next (0.12)
B: Ya- ya ya / [I can see Gaz-
A: [Okay / so go south (0.82) pass th- the Gazelles on the left hand side /

Example 6

The ability to predict the completion point of the current speaker is quite accurate, but failure in prediction occurs and leads to overlaps and violations as can be noticed in examples four to six. The Examples 4 and 5 show how accurately B can predict the turn of A. S/he even forecasts the words which A attempts to use ("Banana Tree"). In the fifth example, B takes the turn and relates after a repetition of A's description, to A's signal word towards a turn: 'Pillars'. B may benefit from the fact that "Fallen Pillars" is a fixed phrase on the map and it is easy to predict that A is going to complete with this phrase.
That an "inactive" interlocutor initiates an overlap, because s/he predicts the intention of the current speaker, is shown in example 6. The current speaker B replies to A's question, first by using a confirmation and then by attempting a specification of the given confirmation. However, A predicts that the confirmation ("ya ya ya") is all the information s/he needs to take this turn and continues with a description ("so go south").

Example 5 and 6 demonstrate that one overlap (Example 6) or an interruption (Example 5) can be multiply listed under more than one category (for example: Confirmation and Prediction).

5.3.3 Full Turn-Taking

FTT, resulting from a violation (e.g. Confirmations or Predictions), happens for various reasons. The conversational partner may decide to change the topic to be more efficient or because s/he recognises that the direction of the conversation so far is misleading.

A: So: that Stone Creek i:s [on your right /

B: [And there is nothin:g there is nothing in between Stone Creek and the: ((the: 120Hz, flat)) / (0.69)

A: No ((259Hz-187Hz)) ./> You next

Example 7

A: Which you might wanna ((wanna: 102Hz, flat)) (0.22) / [go around /

B: [I haven't got one on mine /

Example 8

Whilst example 7 illustrates a prediction of an incorrect fact, example 8 shows B's prediction of irrelevant information from the current speaker.

Another reason for a pre-turn-taking may be impatience. Example 9 and 10 reveal this phenomenon, taken from the end of recorded conversations:

A: Thank [you ./

B: [That was it ./

Example 9

A: You finish ((finish: 145Hz-194Hz)) (?)/> You next (0.28)

B: <Ehm> / (0.33)

A: To the: [west ?/> You next

B: [To the: west of East Lake ./> You next

Example 10

5.3.4 Failed Turn-Taking

We define a FaiTT as the attempt of the current listener to take the turn forcibly without success.

A: <E:h> (0.14) / so where is th- / you saying is like an S (0.07) / where [is the the next part of the S ?/> You next (almost overlap)

B: [So

So you are on the west side of the Disused Monastery ((monastery: 198Hz, flat)) /

Example 11

A: Okay / so there is a [there is another Fenced Meadow above the Caravan Park /> You next then Me further (1.25)

B: [Ya / I've

A:ha ((118Hz-184Hz)) ./> You next (0.55)

Example 12

A: N [north north- ((north: 169Hz-145Hz)) (0.47) [east /

B: [So [east /

Example 13

Examples 11 and 12 demonstrate how the passive interlocutor B tries to intervene. In example 11, B interrupts A by using a confirmation-like signal ("so") in terms of initiating a confirmation by attempting to repeat something that has been said beforehand. He fails in taking the turn from A, because A continues without any hesitation, for example a short pause or an editing term ("ehm"). A turn-taking failure with a pure confirmation ("ya") is shown in example 12. B tries to take the turn too late. The transition relevance place (TRP), a point where the speakers may change, but do not necessarily have to (Seedhouse, 2004), is "Okay". B misses this TRP, so that A is able to complete the whole utterance without stopping or hesitating after B has interrupted. B probably does not continue with the attempt of taking a full turn, when s/he realises that A is providing more information. That a conversational partner can try to benefit from a speech mistake by the current speaker can be seen in example 13. Speaker A hesitates briefly and B tries to take a turn. As in example 12, B stops to process the new information and awaits another upcoming TRP.

5.3.5 Failed Turn-Taking Completed

The category Failed Turn-Taking Completed (FaiTTC) is considered as an additional but autonomous definition of FaiTT with all its features. By analysing the data, it has become obvious that some interruptions were not successful, but they have been completed nonetheless. The interrupted speaker had in such a case more pull.

In the following example, A asked for clarification. However, A found the correct path on the map without further instruction by B. Therefore A initiated an FTT overlap which resulted in an FaiTTC one. A decreased the pitch and marked his/her turn as completed, whilst B continued his/her speech.

A: Which way ((way: 133Hz-124Hz)) (0.16) / again /
B: G [o towards your (0.28)
A: [this one ((one: 241Hz-110Hz)) ./> You next
B: your writing hand /

Example 14

Some Confirmations overlaps were considered as FaiTTC when the acoustical analysis (pitch contour) showed a definite decrease of F0 at the end of the sequence and/or no attempt of continuing the speech could have been detected as it is shown in Example 15.

A: I don’t have to go around the [Fieldstation ((station: 197Hz-218Hz-158Hz)) ?/> You next (2.38)
B: [No: ./> You next
Okay ((243Hz-447Hz)) ?/> You next

Example 15

5.3.6 Others

Laughter, editing terms, significant loud breathing or onset sounds are subsumed under the category Others.
All of these Others features can initiate an overlap or a violation (examples 16-18). Especially if both conversational partners start to laugh, a break down occurs quite often. The listener has to estimate whether the current speaker wants to continue or not. How long will the laughing last, is the laughter a signal for hesitation and a call for turn-taking?

A: I go passed it and [then take a left after the Diamond Mine ./> You next (0.44)
B: [<Ehm> /

Example 16

A: Hm: / I don't have that / <e:h> (0.98) / so that / [((laughter)) /

B: [((Laughter)) /

A: so I don't [know

B: [I /ya: /

((laughter)) / [I just

A: [((Laughter)) /

Okay / <e:h> / to the: west / [right ?/> You next

B: [Ya / (1.71(drawing))

Example 17

A: Ya (0.22) / [then I want you

B: [((Onset sound))

A: to go up along the left hand side of the Highest Viewpoint ((viewpoint: 108Hz-288HZ)) /> You next then Me further

Example 18

5.4 Quantification of Qualitative Measurements

As we hypothesise that the different types of dementia can be characterised by their speech difficulties in conversation, we predict a higher occurrence in speaker change within in the dementia group rather than in the healthy cohort.

In an ideal case we will be able to say that a specific subgroup is detectable by a significantly high or low number of overlaps for certain categories.

The approach of this study is not only to consider turn-taking (and repair) with regard to overlaps, but also to transform qualitative data into a quantitative analysis.

We aim to find parameters of CA that can be analysed through a quantifiable approach. This way, we can be assured that the results could be reproduced and considered reliable in any further data collection.

Qualitative analyses of conversations or social interactions examine how interlocutors use language to accomplish meanings, identities and roles which is important when it comes to an assessment of people with limited cognitive abilities such as in dementia (Yardley and Murray, 2003). Yet, qualitative methods are critically reviewed due to the “lack […] for bridging or translating between the worlds of qualitative and quantitative research” ((Boyatzis, 1998), p.vi). The utility of quantitative methodologies for social behaviour is discussed: “when it comes to dealing with parameters and variables, the best advice seems to be that it may be possible to quantify, but in most cases it doesn't seem to be wise and may actually be counterproductive" ((Smith, 1989), p.30).

The advantage of qualitative data collection is mainly found in the opportunity for providing different viewpoints of people in various situations: "It is necessary to use a method of collecting data that permits the participants to express themselves in ways that are not constrained and dictated by the researcher" (Wilkinson et al., 2004).
According to Boyatzis (1998), the researcher's theory and hypothesis formulate indicators of evidence, moving forward to derive a code for these elements. The code is based on the anticipated meaning of the expected outcome. A generated code has to be reviewed and revised and finally examined for reliability among viewers or when the same person judges and makes the same observation at two different times or two different settings ((Boyatzis, 1998), p.147).
Following Charmaz (2006) (from Smith, 1989), the process of coding links collected data and the development of an emergent theory. Defining observations and their meaning is achieved by this analytic frame.
However, according to Mayring (2001), the dichotomy of separating qualitative and quantitative analysis is false. By considering only one analysis, other aspects of the initial research question may not be answered and the entire picture of the investigated subject cannot be shown.

A widely acknowledged and approved research approach of combining qualitative and quantitative data analysis is embraced by the Grounded Theory. This theory, initially introduced as a legitimisation of qualitative research, has been developed by two sociologists, Glaser and Strauss (1967) for the purpose of constructing theory grounded in data (Corbin and Strauss, 2014). The generation of a theory emerges from systematic research. The methodology behind the Grounded Theory is based on concepts (leading to a theory), which are derived from collected data during the active research process. The research analysis and data collection are interrelated. Following a first data collection and a subsequent analysis, the now updated concepts form the basis for the next data collection. This procedure is an on-going cycle throughout the research process.
According to Corbin and Strauss, written, observed and recorded material can be used for data collection. The key concept is the constant comparison analysis in terms of breaking down the data set into similarities and differences (codes). Similar data are grouped together under the same concept. Continued analysis will form the grouped concepts in to categories. Each category has its different and characteristic features and "eventually the different categories are integrated around a core category. The core category describes in a few words what the researcher identifies as the major theme of the study" ((Corbin and Strauss, 2014), p.8).

Mayring (2001) summarised this theory as a system, which is based on categorisation: the first step is a qualitative analysis of data, the second step includes quantitative procedures and the third step interprets these procedures qualitatively. The author suggested a process-flow model ("Gemeinsames Ablaufmodell" (Mayring, 2001), p.9). Such a research methodology integrates both, qualitative and quantitative analysis:

1. Specification of a research question:
Formulating hypotheses (quantitative) or open research questions (qualitative)
2. Explication of the theory:
Background research (quantitative) or prior understanding (qualitative)

3. Empirical approach:
Description of the sample and material (quantitative) or a single case (qualitative)
4. Methodology:
Explanation and justification of the used procedures (quantitative) or if new methods are tested, a pilot study has to be conducted (qualitative)
5. Results:
Summary and analysis; referring back to the hypotheses (quantitative) or research questions (qualitative)
6. Conclusion
Reliability and relevance of the results (quantitative) or generalisation of "?" (qualitative)

The process, number one to six, of this model is uniform for both qualitative and quantitative research approaches. Mayring (2001) noted that quantitative research benefits from qualitative strategies as the hypotheses are more strongly questioned, whilst the qualitative research enhances transparency and generalizability by considering quantitative methodologies.
As we are dealing with conversational behaviour in this thesis, the following sections will reflect the implementation and contain a discussion regarding combining the two methods of analysis.

The analysis of elements of talk or the deconstruction of linguistic terms enables setting up a code for an understanding of certain incidents in speech (Starks and Trinidad, 2007; Yardley and Murray, 2003). The context of conversations is highly relevant as the roles of the interlocutors are grounded in the activities and relationships of daily life. In their book, Yardley and Murray (2003) reported a content-analysis to quantify discourse analysis to claim that particular elements of talk are typical. Patients' statements were classified in each coding category in order to show their statement pattern: characteristic phrases or contexts, moments of conversational awkwardness, inconsistencies and omissions were considered for analysis. The content analysis revealed coping behaviour in conversations and several elements which were present in two-thirds of the participants: the participant does not consult a doctor, s/he acts as normal, s/he is able to control their illness and/but does not want to cope with it ((Yardley and Murray, 2003), p.94 ff.)

The sociolinguists Gorman and Johnson (Bayley et al., 2013b) noted that a larger data set (of spontaneous speech) creates difficulties in terms of making sense of the raw observations. Therefore, *descriptive statistics*, perhaps in the form of graphical presentation, turn out to be useful to transfer the collected data into numerical values enabling the researcher to focus on meaningful features of the data set. However, descriptive statistics may reach the limit if its techniques “cannot exclude the possibility that this difference [between competing variants] is due to random fluctuations” ((Bayley et al., 2013a), p. 214). The authors suggested considering *inferential statistics* for computing the probability of a specific property due to chance. It should be mentioned that techniques of inferential statistics may be invalid if these are used inappropriately for the present data collection (e.g. enabling wrong conclusions about the population due to sample size).

In 1993, Schegloff reflected on the quantification of conversational data. In his article, he claimed that the statistical relevance of speech data is not the only criterion for establishing significance. Even if quantitative measures of talking and units of speech are not significantly relevant, the linkage between them may be relevant to the interlocutors on that specific occasion. He goes into detail by mentioning that it is important to consider the validity of the way in which certain diagnostic tools are used, such as measuring the number of laughs per minute to show the rate of sociability. However, laughter can be associated with the structure of turns, giving inference about the organisation and planning of a conversation. Schegloff further noted that not only ‘hits’ (occurrences) are relevant, but also non-incidents may count for a holistic conversation and be a way of demonstrating a certain conversational type or different turn-taking system (e.g. speech exchange in interviews or in class). The success of quantitative conversation analysis is, according to the Schegloff, not yet convincingly evident. He questioned if quantitative analysis can counterbalance the “considerable analytic pitfalls that lurk about.” ((Schegloff, 1993), p.117). However, the study of other-initiated repair may be qualified to be considered as a quantitative measurement. A (other-initiated) repair can happen at any time during speech and is not tied to the end of a turn (Benjamin and Mazeland, 2012). According to Schegloff (1993), repair can occur after any turn at talk and its “environments of relevant possible occurrence“ ((Schegloff, 1993), p.115) are well-defined. He further stated that other-initiation of repair and even its sequela can be eligible for quantified methods. Kendrick (2015) justified the quantification (counting the frequency of particular practices and their proportion) of other-initiated repair by confirming

Schegloff et al. (1977)s' assumption about downgrading of other-initiated repair formats (e.g. candidate understandings (strongest), multiple in a turn (weakest)) which are preferred over other formats ((Kendrick, 2015), p.187). Schegloff (1993)'s critique about payoffs of content by using quantitative analysis was contemplated as incremental: "But after more than 35 years of research on other-initiated repair in English, even incremental advances are hard-won" ((Kendrick, 2015), p.187).

In this study, we assume that the mechanism of (other-initiated) repair also includes overlapping of the speaker's current speech. The accepted approach of a quantitative evaluation of other-initiated repairs may therefore be applicable to an analysis of overlaps, based on our categories. We were interested in "what type" of overlap occurs rather than in answering the questions of "where" and "why", allowing a quantification of a qualitative measurement. However, we will refer to literature findings (Chapter 2) and we will conduct case studies, analysing interactions in conversations with dementia patients qualitatively, for further (qualitative) support of the results. This methodological approach is also known as "triangulation". Triangulation can "increase credibility of scientific knowledge by improving both internal consistency and generalizability through combining both quantitative and qualitative methods in the same study" ((Hussein, 2015), p.10).

Schegloff (1993) concluded that a move towards a formal quantitative analysis does not replace informal terms with numbers, but still may be useful to learn from the observed characteristic appearance of conversational behaviour.

Due to lack of literature in dementia addressing Schegloff's critical position concerning the quantification of qualitative data we consider evidence from other disease categories. Aphasiologists seem to be ahead of the argument in favour of quantification in combination with a qualitative analysis of speech data. The research from (Perkins et al., 1999) showed that by using proportions of the number of tokens (in our case: number of Overlaps) the "interactional meaninglessness of using a unit of time as denominator" ((Perkins et al., 1999), p.263) can be avoided. To address the criticism of reliability of conversation across time, Boles and Bombard (1998) found that 5-10 minute samples were representative for certain conversation types when measuring the frequency of the variables: length of utterance; speaking rate and repair. Our speech samples mostly fall into this range and were deemed suitable for such an analysis.

Following Perkins et al. (1999)'s attempt at defining the proportion of turns spent for the total number of turns in collaborative repairs in aphasia, we calculated the proportion for the categories as presented and described in Chapter 5.5.

However, we did not attempt to replace qualitative research by using numbers, but combined quantitative and qualitative analysis as suggested by Schegloff (1993) and Perkins et al. (1999). We interpreted the quantitative results of the patients based on literature findings (qualitative approach) and subjective impressions.

5.5 Quantitative Measurements and Parameters

In this section, we will define the parameters we are going to measure regarding the categories. Further, we will introduce the symbols and equations we have used to compute the measurements and we will discuss the statistical analysis in detail.

1. Acronyms for the studies
Acronyms used in this study are displayed in Table 1 and Table 2.

Healthy study	Acronym
Familiar Non-Lead	F NL H
Unfamiliar Non-Lead	UnF NL H

Table 1 Acronyms for the healthy study

Patient study (including AD and FTD data)	Acronym
Familiar Non-Lead	F NL P / AD / FTD / PNFA / SD / bvFTD
Unfamiliar Non-Lead	UnF NL P / AD / FTD / PNFA / SD / bvFTD

Table 2 Acronyms for the patient studies

2. Acronyms and calculations for our parameters
If not stated otherwise, all calculations were conducted for the NL speakers as we were only interested in their data (Chapter 5.1 and Chapter 6 for further explanations).

Conv	total number of Words for
	Familiar interlocutors:
$F\ L_{H, P, AD, FTD} + F\ NL_{H, P, AD, FTD}$	
	Unfamiliar interlocutors:
$UnF\ L_{H, P, AD, FTD} + UnF\ NL_{H, P, AD, FTD}$	

Words/Conv — Words per Conversation

Words/Conv% — Words per Conversation in %

Familiar Non-Lead interlocutors:

$$\frac{Words}{Conv}\% = \frac{\text{Number of } \frac{Words}{Conv}\ (F\ NL_{H,P,AD,FTD})}{\text{total number of } \frac{Words}{Conv}\ \left(F\ L_{H,P,AD,FTD} + F\ NL_{H,P,AD,FTD}\right)} * 100$$

Unfamiliar Non-Lead interlocutors:

$$\frac{Words}{Conv}\% = \frac{\text{Number of } \frac{Words}{Conv}\ (UnF\ NL_{H,P,AD,FTD})}{\text{total number of } \frac{Words}{Conv}\ \left(UnF\ L_{H,P,AD,FTD} + UnF\ NL_{H,P,AD,FTD}\right)} * 100$$

Overlaps/total number of Overlaps%

Familiar Non-Lead interlocutors:

$$\frac{\text{Overlaps}}{\text{total number of Overlaps}}\% = \frac{\text{Number of } \frac{\text{Overlaps}}{\text{Conv}} \left(\text{F NL}_{\text{H,P,AD,FTD}}\right)}{\text{total number of } \frac{\text{Overlaps}}{\text{Conv}} \left(\text{F L}_{\text{H,P,AD,FTD}} + \text{F NL}_{\text{H,P,AD,FTD}}\right)} * 100$$

Unfamiliar Non-Lead interlocutors:

$$\frac{\text{Overlaps}}{\text{total number of Overlaps}}\% = \frac{\text{Number of } \frac{\text{Overlaps}}{\text{Conv}} \left(\text{UnF NL}_{\text{H,P,AD,FTD}}\right)}{\text{total number of } \frac{\text{Overlaps}}{\text{Conv}} \left(\text{UnF L}_{\text{H,P,AD,FTD}} + \text{UnF NL}_{\text{H,P,AD,FTD}}\right)} * 100$$

Overlaps/Conv — Overlaps per Conversation

Overlaps/Conv% — Overlaps/Conv in %

Familiar Non-Lead interlocutors:

$$\frac{\text{Overlaps}}{\text{Conv}}\% = \frac{\text{Number of } \frac{\text{Overlaps}}{\text{Conv}} \left(\text{F NL}_{\text{H,P,AD,FTD}}\right)}{\text{total number of } \frac{\text{Words}}{\text{Conv}} \left(\text{F L}_{\text{H,P,AD,FTD}} + \text{F NL}_{\text{H,P,AD,FTD}}\right)} * 100$$

Unfamiliar Non-Lead interlocutors:

$$\frac{\text{Overlaps}}{\text{Conv}}\% = \frac{\text{Number of } \frac{\text{Overlaps}}{\text{Conv}} \left(\text{UnF NL}_{\text{H,P,AD,FTD}}\right)}{\text{total number of } \frac{\text{Words}}{\text{Conv}} \left(\text{UnF L}_{\text{H,P,AD,FTD}} + \text{UnF NL}_{\text{H,P,AD,FTD}}\right)} * 100$$

Categories	Number of Confirmations, Predictions, FTT, FaiTT, FaiTTC or Others
Categories%	Number of Confirmations, Predictions, FTT, FaiTT, FaiTTC or Others in %

Example for the category Confirmations%

Familiar Non-Lead interlocutors:

$$\text{Confirmations\%} = \frac{\text{Number of Confirmations } (\text{F NL }_{\text{H,P,AD,FTD}})}{\text{Number of Overlaps } (\text{F NL }_{\text{H,P,AD,FTD}})} * 100$$

Unfamiliar Non-Lead interlocutors:

$$\text{Confirmations\%} = \frac{\text{Number of Confirmations } (\text{UnF NL }_{\text{H,P,AD,FTD}})}{\text{Number of Overlaps } (\text{UnF NL }_{\text{H,P,AD,FTD}})} * 100$$

3. Statistical Analysis

We calculated using the percentages rather than the actual numbers due to the weak control of the length of conversations we exerted. However, we will report numbers and their percentages, but we will focus only on the latter in the final discussion. For the purpose of transparency, we also displayed the numbers for our tested variables.

Shapiro-Wilk test for normality (Shapiro and Wilk, 1965)

First, we have checked our data regarding their (normal) distribution by using the Shapiro-Wilk normality test as this test works well even for a small sample size. The alpha level was 5% ($p > 0.05$ = data are normal).

Two Sample t-test (Snedecor and Cochran, 1989)

If the data were normally distributed, and we wished to compare the means between two groups, we continued the statistical analysis by applying a t-test for independent samples (Two Sample t-test). This test determines if two populations are equal in their means. The alpha level was 0.05 if not stated otherwise.

Mann-Whitney U test

If the compared data sets were not normally distributed, we computed the statistical significance of the difference in the sum of ranks between groups with the nonparametric version of the t-test for independent groups. The statistic U depends on the number of times that a score from one group precedes in rank order the score of another group (Kerby, 2014; Mann & Whitney, 1947). U is computed twice, once for each group whereby the test statistic is the smaller of the two (Kerby, 2014). U becomes important if the calculation of an effect size is of interest. The alpha level was 0.05 if not stated otherwise.

4. Effect size

Effect sizes are an important outcome of quantitative (empirical) research and are used in order to examine if an intervention or a manipulation has a greater effect than zero (Lakens, 2013). The determination of the relative contribution of the same factor in different circumstances or of different factors can be evaluated by estimating the effect size (Fritz et al., 2012). The effect size is calculated by the standardised mean difference between two groups of independent observations for the sample size in terms of standard (Z) scores (Coe, 2002) and is also known as Cohen's *d* (Cohen, 1988):

$$\text{Effect size (Z) or d} = \frac{\text{Mean of experimental group} - \text{Mean of control group}}{\text{Population standard deviation}}$$

There are varieties based on the way the standard deviation (StDev) is calculated, e.g. population standard deviation calculated with a denominator of n (n = number of cases) (proposed by Hedges (1982)). Depending on the data and the research interest, different formulas should be computed to understand and interpret the effect size.

Cohen's *d* interprets the effect size as insignificant or non-existent (d < 0.2), small (*d* > 0.2), medium (*d* > 0.5) and large (*d* >= 0.8).

However, it is noted by Thompson (2007) that even "small effect sizes can have large consequences, such as in an intervention that leads to a reliable reduction in suicide rates with an effect size of *d* = 0.1" (Lakens (2013), p.4). There are currently no clear recommendations of how to explain practical consequences of the effect (Lakens, 2013).

Common Language effect size

We decided to calculate the Common Language effect size (CL), also known as probability of superiority, as it is a more intuitively understandable statistic (McGraw and Wong, 1992).

CL is derived from Cohen's *d* as it can be seen in the **formula [1]** for normally distributed data

$$\text{CL Effect size (Z)} = \frac{|\text{Mean1} - \text{Mean2}|}{\sqrt{(\text{SD1}^2 + \text{SD2}^2)}} \qquad [1]$$

CL gets converted into a percentage and demonstrates "the probability that a randomly selected sampled person from one group will have a higher observed measurement than a randomly sampled person from the other group" (Lakens (2013), p.4). According to Liu ((2013), p.29), CL corresponds to Cohen's *d* with small (0.2) = 0.56 (56%), medium (0.5) = 0.64 (64%) and large (0.8) = 0.71 (71%).

The Z expressed as a percentage is associated with the upper tail probability of Z and for this study, the spreadsheet from the Mathematics Learning Centre, University of Sydney[3] was used in order to calculate CL and its percentage.

So far we have presented the formula for normally distributed data (two sample t-test), however, not normally distributed data were calculated by a different equation. If the Mann-Whitney U test was conducted to find the significance of the difference in the means, we used the following **formula [2]** according to Kerby (2014):

$$\text{Effect size (Z)} = \frac{\mathrm{U}}{\mathrm{N}}, \qquad N = \mathrm{N1} * \mathrm{N2} \qquad [2a]$$

$$\text{CL effect size} = 1 - \mathrm{Z} \qquad [2\mathrm{b}]$$

After the smaller U was set as the test statistic, we ranked the scores (1 = highest number of Overlaps%) and computed the mean ranks% for each group in order to compare these with the distribution of the means% and medians% for the same parameter (e.g. category%). In most cases, the mean ranks% matched the means% and medians%, implying that the predicted direction is likely (e.g. mean ranks%, mean% and median% higher for F than for UnF). If the results of the mean ranks% were contrary to the prediction (e.g. mean ranks% higher for F than for UnF, but mean% and median% higher for UnF than for F), CL was mostly below the small effect size threshold of 56% (*d* = 0.2) which can be interpreted as an insignificant or absent effect for the data% of the F and the UnF speakers. Where the indication from the parameters was contradictory the lack of measureable effect meant that no further analysis was worthwhile.

[3] https://sydney.edu.au/stuserv/documents/maths_learning_centre/normal2010web.pdf

Chapter 6 Expectations

In this chapter, expectations of the conversational behaviour of healthy and AD conversations will be described. These assumptions will be either validated or falsified by the study. We do not provide expectations for FTD conversations as we will present the subtypes, SD, PNFA and bvFTD separately as case studies later on (Chapters 10.4, 10.5 and 10.6).
In the following sections, we will use the terms "L" (Lead) and "NL" (Non-lead). We defined the direction-giver as L and the direction-receiver as NL. Interlocutors who were familiar were appointed with the acronyms F L and F NL. Unfamiliar conversational partners were appointed with the acronyms UnF L and UnF NL. For our patient study, we set the patients always as NL speakers. Therefore, we only considered and analysed the NL data of the healthy study in order to directly compare healthy and dementia speech. Further, our research questions and proposals focus only on the patients' (= NL speakers') turn-taking/ overlapping behaviour in conversations. The influence of the L speakers' conversational behaviour on the NL speakers' speech or vice versa would go beyond the scope of our measurements and would require a formal qualitative analysis.

In the healthy study, we used the acronyms F NL H and UnF NL H for our subjects.
In all studies which included patients, they were always the direction-receiver and therefore named as either F NL P or UnF NL P. Accordingly, we appointed the acronyms F NL AD and UnF NL AD to our AD subjects. (The acronyms F NL FTD and UnF NL FTD were used for the FTD participants).

6.1 Confirmations

We expect a higher number of Confirmations overlaps for the NL AD speakers than for the NL H subjects. Simple structure and less complex phrases and utterances used as feedback overlaps may be used as a method of staying in conversation without providing anymore content even more in disturbed speech in order to mask comprehension difficulties (Ripich et al., 1991).

Healthy data
Confirmation words or signals, if used as an overlap, are commonly accepted by the current speaker and can be tolerated (Sacks et al., 1974). The speech fluency does not necessarily break down. The literature showed that there are diverse opinions about whether a Familiarity effect exists or not (Chapter 2.4). However, we expected that there could be a difference in tendency in the number of Confirmations used between F and UnF conversations.

There might be an increase in the use of Confirmations if unfamiliar interlocutors communicate with each other. The conversational partners might tend to analyse conversational and turn-taking behaviour with greater attention and use more acknowledgments (Cassell et al., 2007) in order to encourage a smooth speech flow with stronger emphasis. Interpretation of the other person’s behaviour in speech can be essential for prediction of turn-givings.
We expect that F NL H speakers will tend to use Confirmations constantly throughout the whole conversation and therefore neither a strong increase nor a decrease will take place. The conversational partners are accustomed with each other's conversational behaviour and know what the most likely reaction of the current speaker will be if the listener choses to chip in with a Confirmation signal.

Alzheimer’s disease data
We expect the number of Confirmations to be higher for the UnF NL AD subjects than for the F NL AD speakers. AD speakers are reportedly affected in their spontaneous speech and we assume that due to the unknown conversational behaviour in the UnF condition, the UnF NL AD speakers will recall simple structured feedback utterances more often than F NL AD participants in order to compensate conversational limitations (Murdoch et al., 1987) and to take part in the conversation with strangers.

6.2 Predictions

In the category Predictions, we think that the number will be greater for the NL AD subjects compared to the NL H speakers. As partners of dementia patients tend to ease conversations (Dijkstra and Bourgeois, 2004), an oversupply of possible TRPs may occur and will result in a higher number of Predictions for these recordings.

Healthy data
We assume that the number of Predictions will be higher for F NL H speakers than for UnF NL H subjects. The ability to predict an upcoming TRP is probably more efficient and accurate if used in a conversation with a familiar person. The forecast of conversational behaviour and speech manner are based on experiences with an interlocutor.
The F NL H participants may use predictions to take the turn before the current speaker has offered a possible TRP to speed the progress of the conversation more often than UnF NL H subjects.

Alzheimer’s disease data

According to diagnostic criteria for AD (McKhann et al., 2011; Snowden et al., 2011), patients suffer from word-finding difficulties and show problems in recalling information. Interrupting L AD speakers at a possible TRP could be used as a method to follow the conversational flow.

We expect a higher number of Predictions for the F NL AD speakers than for UnF NL AD subjects due to the fact that UnF NL AD patients probably tend to be more hesitant and reluctant in their overlaps of the category Predictions and also less able to predict grammatical structures (Sajjadi et al., 2012).

6.3 Full Turn-Taking

We may assume that the NL H subjects will have an increased number of FTT overlaps in comparison to the NL AD participants due to greater confidence in speech. Difficulties in following the description of the journey and concentration limitations might inhibit a Full Turn-Taking, initiated via an overlap by the NL AD subjects. Simultaneous processing of the current speaker’s intention, encoding their syntactical/intonational structures and the patient’s own intentions may be disturbed (Guinn and Habash, 2012; Sabat, 1991).

On the other hand, the conversational Lead of the NL AD patients may be willing to provide more opportunities of giving the turn away which would result in an increased number of FTT overlaps for the AD recordings.

Healthy data

We hypothesise that the number of Full Turn-Takings (FTT) is increased for F NL H speakers compared to the number of FTT of the UnF NL H subjects. Taking the turn earlier/before a TRP, demands some kind of self-confidence of the non-current speaker. The 'passive' interlocutor predicts an upcoming TRP either correctly or interrupts to add a detail, to give feedback or to ask a question. The listener who wants to take a turn is driven by the need to change the direction of the current speaker's speech. We think that an UnF NL H interlocutor will behave more reluctantly and will await a TRP rather than interrupt or initiate an overlap.

Alzheimer’s disease data

We expect that F NL AD speakers will dominate the occurrence of FTT overlaps compared to the NL AD subjects in the UnF condition. We assume that F NL AD speakers are more confident regarding putting an idea across.

6.4 Failed Turn-Taking

We expect a greater occurrence of FaiTT overlaps in the NL H group due to the conversational Lead behaviour. As in healthy conversations, both partners are equally involved; each partner is willing to stop an initiated overlap if, for example the current speaker provides the needed information. In a conversation involving a dementia patient, we assume that the L AD interlocutors will offer more conversational space in order to ease the situation and to bypass the patient's speech difficulties (Dijkstra and Bourgeois, 2004). It may also occur that the L AD speaker will dominate the conversation and therefore force the NL AD patient to withdraw from turn-taking attempts.

Healthy data

We hypothesise that the occurrence of FaiTT is more frequent in the UnF NL H group. UnF NL H speakers might be too polite to take a complete turn out of a violation and hesitate to take the turn fully. If the conversational partner intends to take a turn but stops in the middle, it will result in a higher rate of FaiTT. Also, the current speaker may not recognise the intention of the interruption as the speakers are not familiar with each other`s conversational structure.

Alzheimer's disease data

We assume that UnF NL AD speakers will have a higher frequency of FaiTTs than F NL AD speakers. The speech and language impairment of the AD disease includes limitation of semantic processing and difficulties to see thematic coherence (Sajjadi et al., 2012), therefore a withdrawal from an initiated FTT may possibly be stopped due to either losing the thread or to a strong leadership which overruns any attempt of overlap at of their own confusion and they may tend to be more hesitant and more willing to stop their own speech if they are talking with an unfamiliar person (Ripich et al., 1991).

6.5 Failed Turn-Taking Completed

As we expect for the categories FaiTT, we hypothesise that the NL H subjects will show an increased number of Overlaps for the reasons already mentioned (equal accepted partners).
We think that the L AD's conversational behaviour will likely dominate and guide the conversations with the dementia patients if the speech flow becomes "threatened" and will overrun the overlap. This observation would result in a smaller number of overlaps compared to the NL H group.

Healthy data

For the category FaiTTC, we assume that the number of this type of overlap is higher in the F NL H group due to the fact that F NL H speakers may tend to interrupt each other more often than UnF NL H speakers. We also expect that F NL H speakers are more confident in trying to take a turn and to succeed regarding a completion than NL H speakers in the UnF condition.

Alzheimer's disease data

We predict the number of FaiTTC overlaps to be higher for F NL AD than for UnF NL AD speakers. The F NL AD speakers may tend to increase the frequency of FaiTTCs instead of accepting a failure, with the intention of getting the turn in the end. Against all odds. This behaviour would lead to the assumption of confidence in their speech strategy.

6.6 Others

Due to inhibitions and preserved behaviour in AD speech, we assume that a greater number of Others overlaps is more likely to occur in the NL H data. However, as AD patients also suffer from word-finding difficulties we may observe a higher number of editing terms, therefore a greater number of Others than the NL H speakers can be expected.

Healthy data

As abovementioned (Chapter 5.3.6), the term "Others" is broadly defined here. Others include for example "ehm, e:h, laughter, onset sounds, editing terms". Therefore, it is difficult to specify expectations.

However, we do assume that the mean of the number of Others is higher in the F NL H group due to the fact that these interlocutors may tend to take more risks and they feel more comfortable with each other (e.g. laughter occurrence is increased). On the other hand, the mean of the number of Others may be high in the UnF NL H group, too. Editing terms and hesitant, shy laughter could be a result of their reluctant conversational behaviour.

Alzheimer's disease data

Again, predictions for the category Others cannot made easily. However, we may assume that F NL AD speakers will tend to have a fewer number of Others than UnF NL AD subjects. It is known in the literature that AD patients use an increased frequency of hesitation markers which fall under our category Others (Sajjadi et al., 2012). We expect that hesitant behaviour is more present in UnF NL AD speech.

Chapter 7 Results of the Healthy Study

In this Chapter, we will report and evaluate our recordings and discuss the findings afterwards under the premise of quantitative and qualitative aspects. We wished to explore the suitability of our experimental design for characterising and differentiating healthy and dementia speakers. Further, we wanted to know whether a Familiarity effect exists and whether the effect is able to show differences in the number of Overlaps of healthy, AD and FTD data or not.
We will start by analysing the data of the healthy speakers, looking for evidence of a possible Familiarity effect and ensuring that our categories and the map task are able to characterise healthy speech.

7.1 Healthy Study

We performed the map task (Chapter 5.2, section 1. patient study; map task) with healthy subjects first in order to show that we were able to use it to get detailed information about conversational behaviour in healthy people. We were interested in exploring the following in order to see what normal behaviour was in regard to overlap:

1. whether we find overlaps of the chosen categories (Confirmations, Predictions, FTT, FaiTT, FaiTTC and Others) by using the map task or not in healthy conversations. If any of the overlap types do not show up in healthy speech in a map task then we might not expect them in dementia speech.
2. if a Familiarity effect exists in healthy people.

The results of the healthy study are presented in the following sections.

<u>Numbers of Participants and Age</u>
In total 33 healthy subjects agreed to take part in the study. Some of them participated more than once. Subjects who took part more than once always performed in the same role (Lead (L) or Non-Lead (NL)) but were paired with both F and non-F partners. In the following, we used the synonyms F NL H and UnF NL H for the speakers accordingly. As mentioned earlier, we set the patients always as NL speakers. Therefore, we only considered and analysed the NL data of the healthy study in order to be able to directly compare healthy and dementia speech. Further, our research questions and proposals focus only on the NL speakers' turn-taking/ overlapping behaviour in conversations because this is always the patient role. The influence of the L

speakers' conversational behaviour on the NL speakers' speech or vice versa goes beyond the scope of our measurements and would require a full and formal qualitative analysis.

We had 19 subjects performing as NL H speakers. Five of these speakers were recorded twice, once with a familiar (F) and once with an unfamiliar (UnF) speaker.
On average, the healthy subjects were 32.91 (StDev = 13.46, median = 29, min = 24, max = 81) years old. The NL H speakers had a mean age of 33.52 (StDev = 15.54) years, with a median of 27.5 years. The youngest NL H subject was 24 and the oldest was 81 years old.

We collected 24 recordings in total: 12 conversations for the F condition and 12 for the UnF condition.

Choice of Transcription and Analysis

Five conversations, selected randomly from the set, were marked by two researchers to ensure that the overlap categories were well defined and the marking was repeatable. Any discrepancy was discussed until consensus was achieved.

As our sample size was small and we did not control the conversation length tightly due to our test design, we decided to do the statistical testing with the proportion of the overlap frequency. The number of overlaps may depend on the length of conversation, in other words, the longer the conversation the higher the probability that overlaps occur. To address this issue and to be able to compare the overlapping behaviour for the speakers, we calculated percentage overlap following, if not stated otherwise the procedure of Meteyard and Patterson (2009). Percentage overlap definition is given in Chapter 5.5.

Number of Words per Conversation (number of Words/Conv)

Table 3 summarises the descriptive statistics for number of Words/Conv for the F and UnF conversational pairs.
Table 4 shows the number of Words/Conv for each NL H speaker in the F and the UnF condition. Each box displays one conversation. F NL H and UnF NL H data are not directly linked to each other except where the numbers are printed *italic*. In this case, for one single NL H speaker, two recordings (F and UnF) were collected and the results are placed side by side in one row. The following speakers were recorded under both conditions: 2, 6, 8, 9 and 10.

Familiarity	Mean	StDev	Median	Min	Max
F NL H	274.25	234.93	205.5	66	796
UnF NL H	183.75	58.95	196.5	100	284

Table 3 Descriptive statistics for the number of Words/Conv (healthy study)

We conducted statistical testing to see whether the difference between the mean number of Words/Conv of F NL H and UnF NL H subjects is statistically significant or not. We chose an alpha level of 0.05 for all tests.

First, we analysed the number of Words/Conv to check for normality of distribution by using the Shapiro-Wilk normality test. The outcome showed that the F NL H data were not normally distributed ($W = 0.81$, $p = 0.01$), but the UnF NL H data were ($W = 0.95$, $p = 0.66$). We therefore continued by applying the Mann-Whitney U test as it is a suitable test for data that is not normally distributed. The difference in the sum of ranks for the number of Words/Conv was not significant with $U = 68.5$, $p = 0.84$.

Further, we computed the “common language effect size” (CL) as suggested by McGraw and Wong (1992) and based on Conroy and others' (2012) review of Mann-Whitney statistics by using equation [2] to find the proportion of Z (see Section 5.5 for equations)

As the means and medians suggest that F NL H speakers produced more Words/Conv than the UnF NL H subjects, we wanted to know what the probability of this occurrence was. The effect size (Z) = 0.48, and CL = 0.52, which means that the probability that a randomly selected F NL H speaker will produce more Words/Conv than a randomly selected UnF NL H speaker is 52%. This result revealed that the CL was below the threshold for a small CL effect size (see Chapter 5.5 for explanations regarding the interpretation of the CL and how it corresponds to Cohen’s *d*).

Speaker Number	F NL H	Speaker Number	UnF NL H
1	207 (999)	13	245 (831)
2	*237 (896)*	*2*	*109 (310)*
3	509 (1272)	14	153 (446)
4	796 (1845)	15	145 (495)
5	143 (532)	16	231 (878)
6	*249 (783)*	*6*	*207 (771)*
7	80 (444)	17	115 (554)
8	*91 (575)*	*8*	*284 (1220)*
9	*106 (328)*	*9*	*100 (609)*
10	*603 (1708)*	*10*	*223 (660)*
11	204 (803)	18	194 (571)
12	66 (516)	19	199 (621)

Table 4 Number of Words/Conv for F NL H and UnF NL H speakers (healthy study). The total number of Words/Conv (L H and NL H data) for the F and the UnF group is shown in parenthesis

Table 5 summarises the results for average Words/Conv as percentage data, when the number of Words/Conv of the NL speaker is compared to the total number of Words/Conv for both, L and NL speakers per group (Table 3).

Familiarity	Mean %	StDev %	Median %
F NL H	27.39	9.53	26.67
UnF NL H	28.47	5.96	29.39

Table 5 Descriptive statistics for the number of Words/Conv, produced only by the F/UnF NL speakers, of the total number of Words/Conv produced by both F/UnF NL and F/UnF L speakers in % (healthy study)

We were interested in the number of Words/Conv% of the NL H speaker compared to the total number of Words/Conv% (from L H and NL H speakers) as this number provides information about conversational balance: if the F NL H subjects produced a higher percentage than the UnF NL H speakers it would suggest that the NL H speakers under the F condition may have been more confident in their speech and have contributed more to the speech flow compared to the NL H speakers under the UnF condition.

Table 5 reveals, from consideration of the mean number of Words/Conv% in each case, that the UnF NL H speakers were perhaps proportionately slightly more involved in the conversations than F NL H subjects regarding the number of Words/Conv%.

By looking at the distribution for the five subjects we recorded for both conditions, it is shown for three pairs that the percentage is lower for UnF and in the two remaining cases (speaker 2 and 8) the percentage is higher for UnF NL H subjects (Table 6).

We tested the difference between the mean Words/Conv% of F NL H and UnF NL H subjects. Shapiro-Wilk tests revealed that F NL H and UnF NL H percentage date were normally distributed, with W = 0.97, p = 0.94 (F NL H) and W = 0.91, p = 0.27 (UnF NL H).
A Two Sample t-test was applied to the mean Words/Conv% and showed that the difference between the means was not significant (t(22) = -0.33, p = 0.74).

To evaluate the CL effect size, we applied the formula [1] as described in Chapter 5.5 and found Z = 0.1 (CL = 0.54), indicating that the probability that a randomly selected UnF NL H will produce a greater number of Words/Conv% than a randomly selected F NL H speaker is 54%. CL values of less than 0.56 are generally considered as no effect.

Speaker Number	F NL H Words/Conv%	Speaker Number	UnF NL H Words/Conv%
1	20.72	13	29.48
2	*26.45*	*2*	*35.16*
3	40.02	14	34.30
4	43.14	15	29.29
5	26.88	16	26.31
6	*31.80*	*6*	*26.85*
7	18.02	17	20.76
8	*15.83*	*8*	*23.28*
9	*32.32*	*9*	*16.42*
10	*35.30*	*10*	*33.79*
11	25.40	18	33.98
12	12.79	19	32.05

Table 6 Percentages of the NL H ratio for the number of Words/Conv% for each conversation (healthy study)

Number of Overlaps

Descriptive statistics for the number of overlaps produced by the F NL H subjects and UnF NL H subjects are presented in Table 7.
Table 8 shows the corresponding individual results.

Familiarity	Mean	StDev	Median	Min	Max
F NL H	16	9.47	17	5	32
UnF NL H	12.17	8.65	10.5	2	31

Table 7 Descriptive statistics for the number of Overlaps (healthy study)

Speaker Number	F NL H		Speaker Number	UnF NL H	
1	17	(35)	13	14	(31)
2	*17*	*(36)*	*2*	*5*	*(17)*
3	18	(41)	14	4	(18)
4	32	(52)	15	11	(27)
5	7	(20)	16	21	(37)
6	*26*	*(44)*	*6*	*20*	*(26)*
7	6	(13)	17	4	(14)
8	*6*	*(14)*	*8*	*31*	*(51)*
9	*5*	*(10)*	*9*	*2*	*(6)*
10	*30*	*(60)*	*10*	*10*	*(16)*
11	17	(32)	18	8	(28)
12	11	(14)	19	16	(25)

Table 8 Number of Overlaps for F NL H and UnF NL H speakers (healthy study). The total number of Overlaps/Conv is shown in parentheses

Descriptive statistics for percentage of overlaps are shown in Table 9. The percentages were calculated as described in Chapter 5.5

Table 10 shows the individual percentage data, where we see that two of five recording-pairs showed a higher percentage of overlaps in the F conversations (speakers 2 and 9).

Familiarity	Mean %	StDev %	Median %
F NL H	51.33	11.09	49.29
UnF NL H	45.75	17.9	42.95

Table 9 Descriptive statistics for the number of Overlaps/total number of Overlaps as % (healthy study)

Speaker Number	F NL H	Speaker Number	UnF NL H
1	48.57	13	45.16
2	*47.22*	*2*	*29.41*
3	43.9	14	22.22
4	61.54	15	40.74
5	35	16	56.76
6	*59.09*	*6*	*76.92*
7	46.15	17	28.57
8	*42.86*	*8*	*60.78*
9	*50*	*9*	*33.33*
10	*50*	*10*	*62.5*
11	53.13	18	28.57
12	78.47	19	64

Table 10 Number of Overlaps/total number of Overlaps as % (healthy study)

We tested the difference in the mean for the number of Overlaps/total number of Overlaps% between the F NL H and UnF NL H groups to see whether the difference was significant or not. F and UnF NL H percentage data were normally distributed as Shapiro-Wilk normality tests revealed for F NL H: $W = 0.91$, $p = 0.18$ and for UnF NL H: $W = 0.92$, $p = 0.3$. Proceeding with the Two Sample t-test, the results did not show significant a difference in the percentage means between F NL H and UnF NL H data ($t(22) = -0.91$, $p = 0.37$).

CL was calculated for the number of Overlaps/total number of Overlaps% with the equation for the effect size (Z) with equation [1]. The effect size (Z)= 0.26, which means that CL = 0.6 Considering the means%, the probability that a randomly selected F NL H speaker produces a greater number of Overlaps% than a randomly selected UnF NL H speaker is 60% which is considered to be a small effect.

We further compared the number of Overlaps per Conversation (Overlaps/Conv) as percentage (Overlaps/Conv%) for the F NL H and the UnF NL H data.

The descriptive statistics for the F NL H and UnF NL H speakers regarding the number of Overlaps/Conv% are presented in Table 11.

Familiarity	Mean%	StDev%	Median%
F NL	1.77	0.58	1.72
UnF NL	1.71	0.78	1.65

Table 11 Descriptive statistics for the number of Overlaps/Conv as % (healthy study)

The corresponding individual results (Table 12) show that in four of five F-UnF comparisons a higher percentage for the F condition than for the UnF condition was observed (speaker 2, 6, 9 and 10).

To see whether the difference in the means of the Overlaps/Conv% data was statistically significant or not, we have applied the Mann-Whitney U test, as we did not find normal distribution for the F NL H percentage data ($W = 0.86$, $p = 0.04$). The UnF NL H percentage data were normally distributed, with $W = 0.92$, $p = 0.26$. The U test showed that the difference in the ranks for the percentage of Overlaps/Conv% was not significant, with $U = 71.5$, $p = 0.98$.

We calculated the effect size (Z) with equation [2]. The effect size was $Z = 0.5$ ($CL = 0.5$), implying that the probability that a randomly selected F NL H speaker produces a greater number of Overlaps/Conv% than a randomly selected UnF NL H speaker is 50%.

Speaker Number	F NL H	Speaker Number	UnF NL H
1	1.7	13	1.68
2	*1.9*	*2*	*1.61*
3	1.42	14	0.9
4	1.73	15	2.22
5	1.32	16	2.39
6	*3.32*	*6*	*2.59*
7	1.35	17	0.72
8	*1.04*	*8*	*2.54*
9	*1.52*	*9*	*0.33*
10	*1.76*	*10*	*1.52*
11	2.12	18	1.4
12	2.13	19	2.58

Table 12 Number of Overlaps/Conv as % (healthy study)

Number of Confirmations

Table 13 summarises the results for the F NL H and the UnF NL H speakers for the category Confirmations.

Familiarity	Mean	StDev	Median	Min	Max
F NL H	7.5	6.88	6.5	1	19
UnF NL H	4.83	4.69	3	1	18

Table 13 Descriptive statistics for the number of Confirmations (healthy study)

The number of Confirmations for each conversation can be found in Table 14. The number in parenthesis is the ratio of the number of Confirmations to the total number of Overlaps expressed as a percentage within each group (F NL H and UnF NL H).

Table 15 displays the descriptive data for the number of Confirmations%.

Again, looking at the individual and directly comparable results in *italic* of the F NL H data vs. the UnF NL H percent data, three out of five recording-pairs have a higher percentage under the UnF condition (speakers 8, 6 and 10).

Speaker Number	F NL H		Speaker Number	UnF NL H	
1	7	(41.28)	13	5	(35.71)
2	*9*	*(56.94)*	*2*	*3*	*(60)*
3	1	(5.56)	14	1	(25)
4	16	(50)	15	3	(27.27)
5	2	(28.57)	16	5	(23.81)
6	*19*	*(73.08)*	*6*	*18*	*(90)*
7	1	(16.67)	17	2	(50)
8	*1*	*(16.67)*	*8*	*3*	*(9.68)*
9	*1*	*(20)*	*9*	*1*	*(50)*
10	*18*	*(60)*	*10*	*3*	*(50)*
11	9	(52.94)	18	5	(62,5)
12	6	(54.55)	19	9	(56.25)

Table 14 Number of Confirmations. Percentages are shown in parenthesis (healthy study)

Familiarity	Mean%	StDev%	Median%
F NL H	39.36	21.2	45.64
UnF NL H	43.35	22.2	42.86

Table 15 Descriptive statistics for the number of Confirmations as % (healthy study)

Due to the apparent divergence in the results between the number of Confirmations%, we analysed the difference between the percentage data statistically. First, we calculated the distribution regarding normality by using the Shapiro-Wilk normality test. For both, F NL H ($W = 0.94$, $p = 0.44$) and UnF NL H ($W = 0.95$, $p = 0.7$), we could assume normality. We continued by applying a Two Sample t-test. There was no significant difference in the mean percentages, with $t(22) = -0.45$, $p = 0.66$.
To evaluate the CL effect size, we used equation [1] and found $Z = 0.13$ implying $CL = 0.55$.
For the number of Confirmations%, the probability that a randomly selected UnF NL H speaker shows a higher number of Confirmations than a randomly selected F NL H speaker is 55%, which is below the threshold for interpretation as an effect.

Number of Predictions

The UnF NL H group initiated more overlaps of the category Predictions, considering the means than the F NL H participants as it is displayed in Table 16.

Familiarity	Mean	StDev	Median	Min	Max
F NL H	3.83	2.41	3.5	1	8
UnF NL H	3.5	2.7	3.5	0	9

Table 16 Descriptive statistics for the number of Predictions (healthy study)

The corresponding numbers of Predictions% are shown in Table 17.
By looking at the percentage (in parenthesis) in Table 18, we can see that two out of five conversation-pairs have a higher occurrence of overlaps under the UnF condition (speakers 9 and 10). Considering the means and the means%, we can observe a tendency for a higher number of Predictions(%) for the UnF NL H speakers.

Familiarity	Mean%	StDev%	Median%
F NL H	26.2	12.65	24.88
UnF NL H	28.96	14.51	27.02

Table 17 Descriptive statistics for the number of Predictions as % (healthy study)

We analysed the percentages of the number of Predictions% for F NL H and UnF NL H speakers to detect whether this difference in the data was statistically significant or not. The number of

Predictions% of the F H group was normally distributed (W = 0.96, p = 0.8) as were the UnF H group percentages (W = 0.96, p = 0.69). We applied a Shapiro-Wilk test to examine normality. We proceeded using a Two Sample t-test. The results showed no significant difference between the mean percentages, with t(22) = -0.5, p = 0.62.
We computed the effect size using the formula [1] for normally distributed data resulting in a Z = 0.14 and CL = 0.56. The probability that a randomly selected UnF NL H speaker shows a higher number of Predictions% than a randomly selected F NL H speaker is 56%; a small sized effect.

Speaker Number	F NL H		Speaker Number	UnF NL H	
1	3	(17.65)	13	6	(42.86)
2	*5*	*(29.41)*	*2*	*1*	*(20)*
3	1	(5.56)	14	0	(0)
4	4	(12.5)	15	4	(36.36)
5	3	(42.86)	16	3	(14.29)
6	*6*	*(23.08)*	*6*	*6*	*(30)*
7	1	(16.67)	17	1	(25)
8	*2*	*(33.33)*	*8*	*9*	*(29.03)*
9	*1*	*(20)*	*9*	*1*	*(50)*
10	*8*	*(26.67)*	*10*	*5*	*(50)*
11	7	(41.18)	18	2	(25)
12	5	(45.45)	19	4	(25)

Table 18 Number of Predictions. Percentages are shown in parenthesis (healthy study)

Number of FTT

Table 19 and 20 show the descriptive statistics for the number and percentages of FTT for the F NL H and the UnF NL H speakers whereby the individual results are displayed in Table 21.

Familiarity	Mean	StDev	Median	Min	Max
F NL H	8.42	3.9	8	3	15
UnF NL H	7.33	5.58	7	2	20

Table 19 Descriptive statistics for the number of FTT (healthy study)

Familiarity	Mean%	StDev%	Median%
F NL H	58.5	15.64	53.75
UnF NL H	62.28	19.75	64.08

Table 20 Descriptive statistics for the number of FTT as % (healthy study)

Speaker Number	F NL H		Speaker Number	UnF NL H	
1	9	(52.94)	13	7	(50)
2	*7*	*(41.18)*	*2*	*2*	*(40)*
3	10	(55.56	14	2	(50)
4	14	(43.75)	15	7	(63.64)
5	6	(85.71)	16	14	(66.67)
6	*12*	*(46.15)*	*6*	*6*	*(30)*
7	3	(50)	17	2	(50)
8	*5*	*(83.33)*	*8*	*20*	*(64.52)*
9	*4*	*(80)*	*9*	*2*	*(100)*
10	*15*	*(50)*	*10*	*7*	*(70)*
11	10	(58.82)	18	7	(87.5)
12	6	(54.55)	19	12	(75)

Table 21 Number of FTT. Percentages are shown in parenthesis (healthy study)

The number of FTT% in Table 21 shows higher numbers for the UnF condition in two out of five pairs (speakers 9 and 10).

For our evaluation, we have looked at the difference between the F NL H and UnF NL H percentage for the category FTT, by using a Mann-Whitney U test, as we could only assume normality for the UnF NL H percentages (for F: $W = 0.84$, $p = 0.03$ and for UnF: $W = 0.97$, $p = 0.96$). The difference in the sum of ranks was not significant, with $U = 63$, $p = 0.6$.
We have computed the Z with equation [2]. The effect size (Z) = 0.47 and CL = 0.56, which means that the probability that a randomly selected UnF NL H speaker shows a higher number of FTT% than a randomly selected F NL H speaker is 56%, were considered of having a small effect.

Number of FaiTT

Table 22 shows the number of FaiTT for the F NL H and the UnF NL H participants.

Familiarity	Mean	StDev	Median	Min	Max
F NL H	7.58	5.79	7.5	1	18
UnF NL H	4.83	4.2	3.5	0	14

Table 22 Descriptive statistics for the number of FaiTT (healthy study)

Table 23 summarises the results for each recording. As shown in Table 23, the tendency for the five directly comparable NL H speakers was that three out of five conversation-pairs had a higher number of FaiTT% overlaps in the F condition (speakers 2, 9 and 10). The descriptive statistics for the number of FaiTT% are presented in Table 24.

Speaker Number	F NL H		Speaker Number	UnF NL H	
1	8	(47.06)	13	7	(50)
2	*10*	*(58.82)*	*2*	*3*	*(60)*
3	8	(44.44)	14	2	(50)
4	18	(56.25)	15	4	(36.36)
5	1	(14.29)	16	7	(33.33)
6	*14*	*(53.85)*	*6*	*14*	*(70)*
7	3	(50)	17	2	(50)
8	*1*	*(16.67)*	*8*	*11*	*(35.48)*
9	*1*	*(20)*	*9*	*0*	*(0)*
10	*15*	*(50)*	*10*	*3*	*(30)*
11	7	(41.18)	18	1	(12.5)
12	5	(45.45)	19	4	(25)

Table 23 Number of FaiTT. Percentages are shown in parenthesis (healthy study)

Familiarity	Mean%	StDev%	Median%
F NL H	41.5	15.64	46.26
UnF NL H	37.72	19.76	35.92

Table 24 Descriptive statistics for the number of FaiTT as % (healthy study)

We were interested whether we can find a statistically significant difference between the F NL H and the UnF NL H FaiTT% data or not. The Shapiro-Wilk normality test revealed a normal distribution for the UnF H percentage data (W = 0.97, p = 0.96) and for the F NL H data, with W = 0.84, p = 0.03. Therefore, we continued the analysis by using a Mann-Whitney U test. The difference between the sum of ranks of F NL H and UnF NL H data was not significant (U = 63, p = 0.58).

The effect size for the independent samples was 0.44 and CL = 0.56, implying a small sized effect (equation [1]). We can say that the probability that a randomly selected F NL H speaker shows a higher number of FaiTT% than a randomly selected UnF NL H speaker is 56%.

Number of FaiTTC

An overview of mean, StDev, median, minimum and maximum values for the category FaiTTC are given in Table 25.

Familiarity	Mean	StDev	Median	Min	Max
F NL H	4.17	3.3	3.5	1	12
UnF NL H	2.83	3.95	1.5	0	13

Table 25 Descriptive statistics for the number of FaiTTC (healthy study)

Table 26 and 27 summarise the results as percentages.

Again, we directly compared the five subjects, which we recorded twice and in each condition, the percentages show that only two out of five conversation-pairs had a greater overlap rate under the F condition (speakers 9 and 10).

We evaluated the significance of the difference in the ranks by using the Mann-Whitney U test as the UnF NL H percentage of the number of FaiTTC overlaps (UnF: W = 0.85, p = 0.04) and the F NL H data were not normally distributed, with: W = 0.87, p = 0.08. The U test showed no significant differences in the sum of ranks, with U = 42.5, p = 0.09.

To compute the Z and CL, we applied equation [2]. Based on this calculation, we can say that the probability that a randomly selected F NL H speaker shows a higher occurrence of FaiTTC% than a randomly selected UnF NL H speaker is 73% (Z = 0.3 and CL = 0.7), a medium sized effect.

Familiarity	Mean%	StDev%	Median%
F NL H	26.75	12.61	21.11
UnF NL H	19.33	19.23	13.4

Table 26 Descriptive statistics for the number of FaiTTC as % (healthy study)

Speaker Number	F NL H		Speaker Number	UnF NL H	
1	5	(29.41)	13	2	(14.29)
2	*6*	*(37.5)*	*2*	*2*	*(40)*
3	4	(22.22)	14	0	(0)
4	7	(53.13)	15	0	(0)
5	1	(14.29)	16	7	(33.33)
6	*12*	*(46.15)*	*6*	*13*	*(65)*
7	1	(16.67)	17	1	(25)
8	*1*	*(16.67)*	*8*	*6*	*19.35)*
9	*1*	*(20)*	*9*	*0*	*(0)*
10	*6*	*(20)*	*10*	*1*	*(10)*
11	3	(17.65)	18	1	(12.5)
12	3	(27.27)	19	2	(12.5)

Table 27 Number of FaiTTC. Percentages are shown in parenthesis (healthy study)

<u>Number of Others</u>

The descriptive statistics for the number of Others are displayed in Table 28. Table 29 shows the descriptive statistics as percentage.

Familiarity	Mean	StDev	Median	Min	Max
F NL H	2.25	2.6	1	0	7
UnF NL H	3	4.67	1.5	0	15

Table 28 Descriptive statistics for the number of Others (healthy study)

Familiarity	Mean%	StDev%	Median%
F NL H	17.25	19.53	7.67
UnF NL H	21.52	21.76	12.5

Table 29 Descriptive statistics for the number of Others as % (healthy study)

Looking at Table 30 and the individuals we have recorded under both conditions (*italic*), it can be seen that none out the five recording-pairs showed a higher outcome for overlaps in the category Others under the F condition. However, two F/UnF pairs showed no overlaps for two NL H speakers (speakers 6 and 9).

We tested the difference of the percent of the number of Others to see whether F NL H speakers produced statistically significantly more overlaps of the category Others% than the UnF NL H speakers as the means% suggest.

Shapiro-Wilk normality tests revealed that neither mean number F NL H nor mean number UnF NL H were normally distributed, with F: W = 0.82, p = 0.01 and UnF: W = 0.8, p = 0.01. A Mann-Whitney U test did not show significant differences in the sum of ranks, with U = 64, p = 0.64. Further, we wanted to know the CL for the number of Others% by using equation [2]. We have computed that the probability that a randomly selected UnF NL H speaker shows a higher number of Others% than a randomly selected F NL H speaker is 56% (Z = 0.44 and CL = 0.56). A small effect was found.

Speaker Number	F NL H		Speaker Number	UnF NL H	
1	4	(23.53)	13	2	(50)
2	*1*	*(6.25)*	*2*	*0*	*(0)*
3	7	(38.89)	14	0	(0)
4	0	(0)	15	3	(27.27)
5	0	(0)	16	10	(47.62)
6	*0*	*(0)*	*6*	*0*	*(0)*
7	3	(50)	17	2	(50)
8	*3*	*(50)*	*8*	*15*	*(48.39)*
9	*0*	*(0)*	*9*	*0*	*(0)*
10	*7*	*(23.33)*	*10*	*1*	*(10)*
11	1	(5.88)	18	1	(12.5)
12	1	(9.09)	19	2	(12.5)

Table 30 Number of Others. Percentages are shown in parenthesis (healthy study)

Distribution of Categorical Percentages of the number of Overlaps

After evaluating all the parameters above in terms of numbers and percentages, we calculated the portion of the total number of Overlaps% per category (Table 31). As we have marked each overlap most of the time as two or even three samples of a category, the numbers of Confirmations%, Predictions% and Others% does not sum up to 100%. However, the categories FTT and FaiTT result in 100% as an overlap had to be either Fully succeeded or Failed.

The categories FTT and Confirmations had the largest portions of the number of Overlaps whereas the category Others was found to be the smallest portion. Considering the medians%, the number of Confirmations% and the number of FaiTT% were very close in their values.
The percentage for the categories FTT and FaiTT reveal that the participants, on average, succeeded more often in Taking a Turn Fully rather than Failing the Turn-Taking.

	Confirmations%	Predictions%	FTT%	FaiTT%	FaiTTC%	Others%
Mean%	41.35	27.58	60.39	39.61	23.04	19.39
SD%	21.33	13.39	17.53	17.53	16.35	20.34
Median%	45.64	25.84	55.06	44.95	19.68	11.25

Table 31 Ratio of categories% of the number of Overlaps (healthy study)

7.2 Discussion

The aims of the healthy study were to find answers to the following questions:

1. Do we find overlaps of the chosen categories (Confirmations, Predictions, FTT, FaiTT, FaiTTC and Others) by using the map task or not in healthy conversations?
2. Does a Familiarity effect exist in healthy people?

Due to our experimental design, we did not control the conversation length tightly as we mentioned at the beginning of this section. To be able to compare the overlapping behaviour for the speakers and categories, we calculated percentage overlap.
We considered descriptive statistics for the numbers and percentages of overlaps for the categories and additionally used suitable statistical testing to determine if the difference in our data between F NL H and UnF NL H speakers were significant.

Suitability of the map task for finding overlaps of the chosen categories (Confirmations, Predictions, FTT, FaiTT, FaiTTC and Others) in healthy conversations
We found that a large portion of the overlaps was labelled as FTT and Confirmations. Most of the time the NL H speakers used Confirmations overlaps in order to take turns. The success rate of turn-taking initiated through an overlap was 60%. The constant feedback through Confirmation by the NL H participants seemed to be a tool for contributing to the conversational flow.
The categories FaiTTC and Others were less numerous in the conversations. FaiTTC overlaps were always part of the FaiTT category; we found that 58% of the FaiTT overlaps had been labelled as

FaiTTC. Though the NL H speakers Failed in Taking the overall Turn, they completed their utterance or turn anyway.
We showed with our data a measurable difference between FTT% and FaiTT% as well as the clear difference of almost 20% between FaiTT% and FaiTTC%.
All speakers confirmed at least once. In the category Predictions, only one speaker did not initiate an overlap demonstrating that as well as feedback during conversations, the predictive ability of current speech is a good technique in order to achieve efficiency, too. We did not find a lot of Others overlaps, leading to the assumption that the categories Confirmations and Predictions are good representatives for dominant conversational behaviour regarding turn-taking.
As we found a measurable difference between Full and Failed turn-takings, we conclude that these categories are promising measures in order to characterise the conversational behaviour of our NL H subjects.

According to Seedhouse (2004), the norm dictates that when the current speaker is overlapped, the interlocutor will most likely “follow the norms by ceding the turn” ((Seedhouse, 2004), p.30). The “strategic behaviour” in terms of aiming for a completed turn-taking as a result of an overlap was shown capably and emphasized in the type of overlap in order to achieve completion.
Two of our categories describe the capacity of planning and execution of an intended overlap whilst processing the input of the conversational partner simultaneously. This procedure seems to be a complicated, complex and overwhelming task (Ford and Thompson, 1996; Sacks et al., 1974) , but our participants capably demonstrated this ability as our data in Table 31show.
In order to achieve an FTT, our subjects produced a high number of Confirmations, a conversational accepted tool regarding overlap behaviour which usually does not cause a conversation break-down ((Seedhouse, 2004), p.28-29): “It is quite common for preferred, affiliative second turns such as acceptance of an invitation or agreement to be undertaken in overlap before the transition relevance place point”. All speakers confirmed at least once per conversation.
Not only are Confirmations common, but also Predictions emerged from an overlap. Schegloff (1996) states that when a TCU comes to a possible completion or a prediction of textual and grammatical sequence takes place, an initiated Prediction overlap is the most common usage by continuing further talk. Only one speaker did not use Predictions overlap throughout the conversation. This NL H speaker used 4 overlaps in total, in a 446 words long conversation.

We found examples of all categories in the healthy conversations which shows that the Map task was able to produce enough kinds of overlaps in healthy speech. In Chapter 5.2 we presented literature findings and opinions about the Map task and its provision of extracting specific characteristics of speech, also regarding the occurrence of overlaps. We have chosen a set of features from already existing definitions of overlap categories and adjusted these towards our research interest respectively compiled our own list of definitions based on the common descriptions (Chapter 5.3).

Regarding our approach of looking for a Familiarity effect in our data, we statistically tested the difference in mean percentages or the ranks (as appropriate) between F NL H and UnF NL H speakers to determine a difference.
Due to our sample size being small (n = 24), we could not show a statistically significant difference.

In the sections above, we decided to report the numbers as well as percentages in order to show a tendency of behaviour for those speakers who we were able to record twice.

As mentioned earlier (Chapter 5.5), we calculated the percentages rather than the actual numbers due to the weak control of the length of conversations we exerted. Therefore, we generally considered only the percentage data for statistical comparison between F NL H and UnF NL H subjects. The number of Words/Conv was reported, however, as this variable is used as a reference calculations of the number of Overlaps ratios for each category.

<u>Familiarity Effect</u>
We statistically analysed the number of Words/Conv, number of Words/Conv%, number of Overlaps/Conv%, number of Overlaps/total number of Overlaps% and the six categories of Overlap, we defined in Chapter 5.3 to determine if there was an observable Familiarity effect.
For five out of ten analysed variables (mean of the number Words/Conv, Overlaps/Conv%, Overlaps/total number of Overlaps%, FaiTT% and FaiTTC%), the F NL H means% were higher than for the UnF NL H percentage data.
By looking at the medians the following variables were higher for F NL H speakers than for UnF NL H subjects: number of Words/Conv, Overlaps/Conv%, Overlaps/total number of Overlaps%, Confirmations%, FaiTT% and FaiTTC% (six out of ten).

We interpret the high number for the Words/Conv and also the higher number of Overlaps/Conv% for the categories in the F NL H group as an indication of a greater confidence in conversational behaviour and the trust of the interlocutors that a conversational break down will not occur, even if overlaps are initiated (Cassell et al., 2007). The research of Yuan et al. (2007), that we outlined in Chapter 2.4, supports our findings: the accommodation to a familiar conversational style and more animated conversations lead to more overlaps. However, their

experimental design was different from ours (see Chapter 2.4) and a direct comparison of familiar and unfamiliar conversational speech behaviour was not given in Yuan et al. (2007) as two different corpora were used.
The study of Bortfeld et al. (2001) (see a discussion below and Chapter 2.4) found a different behaviour, though the differences between familiar and unfamiliar interlocutors were not significantly different, strangers overlapped more often than familiar pairs. Their explanation for this outcome was that the better interlocutors know each other, the better their coordination and the smaller the number of Overlaps/Conv. We assume that the difference between their and our result may be due to the fact that we only analysed the overlapping behaviour of NL speakers instead of pairs.

In Chapter 6, we predicted higher numbers for F NL H speakers in the categories Confirmations, Predictions, FTT and FaiTTC. We did not make any specific predictions for Others as we defined this category quite broadly.

However, the category Confirmations showed a higher mean% for the UnF NL H speakers, which was in agreement with our assumption that UnF NL H speakers initiate more feedback overlaps than F NL H speakers. The difference between the means% was relatively small. The median% was, in contrast, higher for F NL H speakers than for NL H speakers in the UnF group, but with an even smaller difference. The diverse result for the means%' and medians%' distribution was expressed in the lack of effect and the finding of no significant difference in the statistical testing for the means%. According to the paper of Cassell et al. (2007), which investigated the role of increasing friendship in spoken dialogues, they noted that UnF NL H speakers used more "acknowledgments" than F NL H subjects. In our healthy study, we confirmed this observation by considering the mean Confirmations%.

In the category Predictions, the UnF NL H mean% and median% were higher than the F NL H percentages, which is contrary to our assumption that Predictions is a feature that familiar interlocutors would use more than UnF H speakers, based on the benefit of knowing each other's speech and language behaviour. We expected F NL H speakers to be able to predict a possible or upcoming TRP more often that UnF NL H speakers and to use that information in order to speed up the speech flow and increase the efficiency of the conversational goal; finishing the task.
The Two Sample t-test did not show significant difference between the means%. However, by considering the small sized effect of 61%, we may expect a small increased probability over chance that any given UnF NL H speaker predicts a possible TRP more often than any given F NL H speakers.

This result might be due to an increased attention to the conversational behaviour of the L H speakers (Cassell et al., 2007). Particular attention towards the wording and timing might lead to a greater occurrence of predictions during a conversation with UnF L H interlocutors. In the paper of Baker et al. (2008), which explored the anticipation of redundancy in response to listener confusion in a task oriented dialogue, it was found that direction-givers (here the L H speakers), when confusion was anticipated, tend to be more engaged in trouble-solving with strangers than with friends. This finding would support our expectation that UnF NL H speakers were more involved in initiating Predictions% in order to avoid a possible conversational break-down.

Looking at the results for the category FTT, our expectation of a higher number for F NL H speakers was not confirmed for the means% and medians%. However, the difference between F NL H and UnF NL H speakers is small. The medians% showed in contrast to the means% that UnF NL H speakers had higher difference in numbers% than F NL H speakers. We did not find a statistically significant difference for the sum of ranks, but we found a small effect. Considering the medians% and the CL result, we have to reconsider our assumption that F NL H speakers produced more FTTs than UnF NL H speakers, especially because the difference between the means% is too low to favour F NL H speaker results over UnF NL H subject results.
The fact that UnF NL H speakers succeeded in taking a Full Turn out of an overlap more often than F NL H participants, could be due to the UnF L H speakers hesitating to continue their speech if the UnF partner overlaps the current speaker due to uncertainty about the conversational behaviour and the increased risk of an interruption of the total speech flow. In contrast, as found in Cassell et al. (2007) study, proactively checking back is a conversational behaviour of F NL speakers rather than UnF NL speakers, resulting in a higher number of (Full) Turn-Takings. The authors concluded that familiar interlocutors are “less concerned with maintaining positivity during the interaction” ((Cassell et al., 2007), p.48).

The FaiTT results showed that both means% and medians% had a higher number of overlaps for the F NL H speakers. We observed the greatest difference between the medians% found in any category. We assumed that UnF NL H speakers would have a higher outcome in the FaiTT number, but the descriptive statistics told us otherwise. Statistical testing did not show a significant difference. We calculated a small sized effect, favouring the F NL H speakers over the UnF NL H subjects. Apparently, the F NL H participants were more willing to stop an initiated turn-taking than the UnF NL H speakers. As it is described in (Cassell et al., 2007), familiar interlocutors show “less need to negotiate understanding , and that they [familiar interlocutors] are more likely to have some kind of shared representation” ((Cassell et al., 2007), p.47). This in turn means that F NL H subjects are more likely to withdraw their initiated FTT as a mutual understanding is probably achieved in shorter time.

A dominant behaviour of their interlocutors (F L H speakers) may be the reason for a higher mean% for the F NL H subjects compared to the UnF NL H mean%. UnF L H speakers may have been more hesitant and have stopped their own speech rather than hold on to their current turn.

We expected that the occurrence of FaiTTC would be higher for F NL H speakers. The means% and medians% supported this expectation. The differences between the means% and especially the medians% were high. We observed the greatest difference between the means% found in any category. The mean ranks showed a significantly higher value for the F NL H speakers resulting in a medium sized effect of 0.7 favouring a higher occurrence of FaiTTC in the F NL H group over the UnF NL H one.
Taking all these outcomes into account, a significant Familiarity effect in the parameters for FaiTTC was found so our expectations for this parameter was confirmed in our healthy cohort.

The category Others showed a higher number of overlaps% for UnF NL H considering the mean% and median%. We did not find a statistically significant difference in the sum of ranks, but a small effect (CL = 0.56) indicating that a randomly selected UnF NL H speaker is slightly more likely to produce overlaps% in the Others category than a randomly selected F NL H speaker is. Based on our measurements, the category Others was not able to show a significant difference regarding Familiarity, but a small sized effect was detected.

Our expectations were confounded for the category Confirmations and FaiTTC when considering the means% and for the category FaiTTC when considering the medians%. In general, the F NL speakers did take the risk of an interrupted speech flow more often than the UnF NL H speakers.

Considering the descriptive statistics and the statistical testing, we found differences between F NL H and UnF NL H behaviour in several different categories; in the number of Confirmations%, FTT%, FaiTT%, FaiTTC% and Others% a greater difference between F NL H and UnF NL H was observed.

We found small sized effects for Overlaps/total number of Overlaps%, Predictions%, FTT%, FaiTT, Others% and a medium sized effect for FaiTTC%.
For the categories FaiTT% and FaiTTC%, there was a small and medium probability respectively that a randomly selected F NL H speaker showed a greater number of overlaps% than a randomly selected UnF NL H speaker. The opposite effect was found for the category Predictions%, FTT% and Others% where the probability was that a randomly selected UnF NL H speaker would show a higher number of overlaps% than a randomly selected F NL H speaker.

Our observations do not match with the findings reported in the literature, which we discussed in Chapter 2. Though many authors expected a Familiarity effect in their conversation data, not all could show a difference between familiar and unfamiliar speakers (Bortfeld et al., 2001; Branigan et al., 1999; Cassell et al., 2007). They expected that an over simplification of parameters or the experimental design may have caused the lack of finding a Familiarity effect. As we were looking at overlapping behaviour in conversation in healthy speech, we compared the literature findings with our results:

Bortfeld et al. (2001) found a significant difference in the number of times in which one partner's speech overlapped the other's. They counted overlaps per utterance, which consisted of 100 words from a larger conversation (word counts ranged from 245 to 825). Pairs of strangers overlapped each other more often than familiar pairs. They did not find a significant difference between the overlap numbers of the NL speakers though.

Seemingly, our approach of testing the percentages in order to control the conversation length was more revealing for finding a tendency of a Familiarity effect than using the raw numbers of words and overlaps. We did not restrict the analysed portion of the conversation to a specific number of words and therefore we were able to consider the distribution of different types of overlaps throughout an entire conversation in order to look for any difference between the F NL H and the UnF NL H speakers.

Yuan et al. (2007) looked at the occurrence of overlaps in conversations between friends and strangers by using conversational telephone speech. The authors found a statistically significant difference in the number of Overlaps between UnF and F interlocutors. When talking with strangers, the participants tended to overlap each other's speech less often than familiar subjects. This outcome is contradictory to the finding from Bortfeld et al. (2001). Yuan et al. (2007) did not look at the difference between the conversation sides as they could not investigate an F NL versus an UnF NL difference due to their experimental design (see Section 2.4).

However, when F and UnF data were compared, our results showed that UnF interlocutors overlapped more often than F speakers which is in agreement with Bortfeld et al. (2001)'s outcome. In our study, the mean percentage for the overlap ratio (total number of Overlaps/total number of Words) for the F H group was 3.47% and for the UnF H speakers 3.78%. We have used a similar design to Bortfeld et al. (2001), and our findings regarding the distribution of F and UnF data were similar.

However, both, Bortfeld et al. (2001) and Yuan et al. (2007) found a statistically significant difference for the number of Overlaps between F and UnF data and therefore evidence for a Familiarity effect in their corpora. Unfortunately, no statistically significant difference between F NL and UnF NL data was investigated.

Summary

A large portion of the overlaps was labelled as FTT and Confirmations. Most of the time the NL H speakers used Confirmations overlaps in order to take turns successfully. The constant feedback through Confirmation by the NL H participants seemed to be a tool for contributing to the conversational flow. All speakers confirmed at least once per conversation. As an initiated Prediction overlap is the most common exploitation by continuing further talk, our subjects did use this category as possibility to increase speech efficiency in most of the times. Only one speaker did not use Predictions overlap throughout the conversation.

We showed with our data a measurable difference between the percentages of FTT%, FaiTT% and FaiTTC%.

Based on our findings, we were able to measure the distribution of categorical data and their differences. Considering our first research question regarding the usefulness of the map task in order to get enough overlap types for characterising healthy speech from spontaneous speech (Chapter 5.2, map task), our observations support the suitability of our parameters extracted from the recordings derived by the map task to analyse healthy speech regarding overlaps.

The parameters which supported the existence of a Familiarity effect in healthy subjects in our study were the number of Overlaps/total number of Overlaps%, Predictions%, FTT%, FaiTT%, FaiTTC% and Others%. We were not able to show a Familiarity effect for the number of Words/Conv, Words/Conv%, Overlaps/Conv% and Confirmations%.

So on balance and by considering the outcome for the categories, we think that there is evidence for a Familiarity effect in our study.

As we have found promising indicators for a Familiarity effect derived by the map task recordings, we were confident to extend the methodology to consider a possible Familiarity effect as well as changes of overlaps, in numbers of types, in NL speakers with dementia.

Chapter 8 Results of the Patient Study

In this Chapter, we will continue our analysis of patient and AD data by applying the same statistical evaluation and calculations (Chapter 7).

8.1 Patient Study - Initial Recording

We performed the map task described in Chapter 5.2 with dementia subjects, as well as healthy subjects in order to show that we were able to use it to get detailed information about conversational behaviour in AD, SD, PNFA and bvFTD speech. As we confirmed the suitability of the using the Map task in order to measure the chosen categories, we were interested in answering the following questions that were similar to those of the healthy study, in order to describe and characterise turn-taking behaviour in the form of overlaps:

1. Are the chosen categories (Confirmations, Predictions, FTT, FaiTT, FaiTTC and Others) measurable or not in conversations including dementia patients?
2. Does a Familiarity effect exist in the speech of people with dementia?

For the patient study, we used the acronyms described in Section 5.5.

The results of the patient study are presented in the following sections. We pooled the AD and FTD data to get more power for our statistical analysis. Having shown that that the FTD data did not have a significant impact on the differences between the means of the overall patient data expressed as percentages, we conducted Two Sample t-tests and Mann-Whitney U tests for each category and for each condition. For example we contrasted for the F NL P speakers: AD+FTD Confirmations% (mean = 34.23%, StDev = 18.67%, median = 30.2%) versus AD-FTD Confirmations% (mean = 32.5%, StDev = 16.1%, median = 30.77%) and likewise for the other overlap categories using Two Sample t-tests to explore the difference in the mean percentages. No Two Sample t-test showed a significant difference for the mean percentages for any tested parameter. Based on this outcome, we continued our statistical analysis with pooled percentage data.

However, we also present the AD percentages in this section to contrast with the overall patient percentages. If the AD data are not explicitly mentioned (e.g. “F NL AD” or “UnF NL AD”), all descriptions relate to the pooled patients’ outcome. The section Discussion only reviews the AD outcomes regarding the descriptive statistics and the CL effect size, but refers to the statistical results of the overall patient data where we find statistical significance. The FTD cases are analysed separately in Chapter 10.

Number of Participants and Age

In total 30 subjects (12 patients, 12 familiar and six unfamiliar partners to the patients) agreed to take part in the study. Nine patients were female and three male, five familiar partners were female and seven were male. All unfamiliar partners were women.

In a first recording session, we recorded the 12 patients (nine AD and three FTD patients) with a familiar (F L P) and nine patients with an unfamiliar person (UnF L P) (six AD patients and three FTD patients). One UnF L P subject was involved in five recordings, another one in two recordings and two others interacted with one patient each. In a second recording session, which took place after a few months, four patients (two AD and two FTD patients) were recorded with their carers or partners (F L AD/FTD) and one of these was recorded with an UnF participant, too (five recordings). Only one FTD patient was recorded a third time, one year after his first recording, with his spouse (one recording).

We collected 27 recordings in total.

In the following section we will report the results of the first recording session (21 recordings).

On average, the patients were 75.86 (StDev = 9.23, median = 71, min = 67, max = 83) years old. The F L P subjects had a mean age of 62 (StDev = 17.8, median = 65, min = 38, max = 80), whilst the UnF L P speakers had a mean of 31.83 years (StDev = 11, median = 27.5, min = 22, max = 50).

Choice of Analysis

For our patient study, as discussed in Chapter 5, we set the patients always as NL speakers. The influence of the carers' conversational behaviour on the patients' speech or vice versa will not be discussed as it goes beyond the scope of our research questions.

Again, as our sample size is small and we did not control the conversation length tightly due to our test design, we decided to do the statistical testing with the proportion of the overlap frequency. We calculated overlap percentages following the procedure of Meteyard and Patterson (2009) if not stated otherwise. Percentage overlap definition is given in Chapter 5.5.

Number of Words/Conv

The mean Words/Conv of the NL AD subjects was higher under the F condition (difference = 1.66), but lower for the UnF NL AD subjects (difference = 4.44) as compared to the overall patients' data. However, the medians were higher for both the F NL AD and the UnF NL AD speakers in contrast to the patients' data.

Table 32 and 33 summarise respectively the descriptive statistics for number of Words/Conv for all patients and for AD subjects only.

Familiarity	Mean	StDev	Median	Min	Max
F NL P	169.67	97.65	168.5	25	397
UnF NL P	152.44	105.68	124	18	328

Table 32 Descriptive statistics for the number of Words/Conv (patient study)

Familiarity	Mean	StDev	Median	Min	Max
F NL AD	171.33	108.92	175	25	397
UnF NL AD	148	96.54	146	18	292

Table 33 Descriptive statistics for the number of Words/Conv (AD subjects only)

Table 34 shows the number of Words/Conv for each NL P speaker in the F and the UnF condition. Each box displays one conversation. A blank box indicates a lack of recording under either the F or the UnF condition. Data from the FTD subjects are the numbers that are printed in *italic* (speakers 1 (bvFTD), 2 (SD) and 3 (PNFA)).

Nine patients were recorded under both conditions (speakers 1, 2, 3, 4, 7, 8, 10, 11, and 12).

Speaker Number	F NL P	Speaker Number	UnF NL P
1	*237 (1010)*	*1*	*97 (362)*
2	*136 (581)*	*2*	*328 (681)*
3	*121 (803)*	*3*	*59 (196)*
4	397 (1368)	4	124 (337)
5	175 (728)		
6	113 (152)		
7	25 (487)	7	18 (216)
8	210 (818)	8	168 (483)
9	50 (385)		
10	162 (518)	10	80 (369)
11	188 (654)	11	206 (417)
12	222 (730)	12	292 (419)

Table 34 Number of Words/Conv. Total number of Words/Conv are shown in parenthesis (patient study). Speaker 4 to 12 display the results for the AD subjects.

We conducted statistical testing to see whether the difference between the mean number of Words/Conv of F NL P and UnF NL P subjects is statistically significant or not.
First, we analysed the number of Words/Conv to check for normality of distribution by using the Shapiro-Wilk normality test. The F NL P data were normally distributed (W = 0.94, p = 0.47) as well as the UnF NL P data were (W = 0.94, p = 0.58). We therefore continued by applying the Two Sample t-test as it is a suitable test for data that is normally distributed. The difference in the means for the number of Words/Conv was not found to be statistically significant, with t(19) = 0.39, p = 0.7.
Further, we computed the CL as suggested by McGraw and Wong (1992). We have calculated the CL with equation [1]; Z = 0.12 and CL = 0.55.
As the means and medians suggest that F NL P speakers produced more Words/Conv than the UnF NL P subjects, the probability that a randomly selected F NL P speaker will produce more Words/Conv than a randomly selected UnF NL P speaker is 55%. We found no effect as the CL was below the threshold for observing an effect.

Further, we calculated the CL for the F NL AD and the UnF NL AD subjects by using equation [1] as for the AD data, we found normal distribution for both, F NL AD and UnF NL AD speakers (F NL AD: W = 0.93, p = 0.45 and UnF NL AD: W = 0.1, p = 0.1). The probability that a randomly selected F NL AD speaker will produce a greater number of Words/Conv than a randomly selected UnF NL AD speaker is 56%; a small sized effect (Z = 0.16, CL = 0.56).

Table 35 summarises the results for average Words/Conv as percentage data, for both, L P and NL P speakers per group. Table 37 displays the percentages of the F NL AD and UnF NL AD subjects. The means% and medians% were higher for F NL AD speakers and lower for UnF NL AD participants when the percentages are compared to the percentage data in Table 35.

Familiarity	Mean%	StDev%	Median%
F NL P	26.96	16.87	24.86
UnF NL P	36.19	17.87	34.78

Table 35 Descriptive statistics for the number of Words/Conv of the total number of Words/Conv as % (patient study).

Familiarity	Mean%	StDev%	Median%
F NL AD	29.07	19.12	28.75
UnF NL AD	36.78	21.37	35.79

Table 36 Descriptive statistics for the number of Words/Conv of the total number of Words/Conv as % (AD subjects only).

We were interested in the number of Words/Conv of the NL P speakers compared to the total number of Words/Conv (from L P and NL P speakers) expressed as a percentage. A higher percentage for the F condition than the UnF condition would suggest that the NL P F speakers may have been more confident in their speech and have contributed more to the speech flow compared to the UnF NL P speakers; the reverse finding would suggest the opposite to be true. Comparing Tables 35 and 37 reveals that the UnF NL P speakers were on average proportionately slightly more involved in the conversations than F NL P subjects regarding the number of Words/Conv% though there were large subject to subject variations.

Looking at the distribution for the subjects we could record for both conditions (Table 37), it is shown for six pairs that the percentage is higher for UnF NL P and in the three remaining (AD) cases (speakers 4, 8 and 12) the percentage is higher for F NL P subjects.

We tested the difference between the means% of F NL P and UnF NL P subjects. Shapiro-Wilk tests revealed that F NL P percentages were not normally distributed ($W = 0.77$, $p = 0.004$), but UnF NL P percentages were normally distributed, with $W = 0.98$, $p = 0.95$.

A Mann-Whitney U test was applied to the percentages and showed that the difference in the sum of ranks was not significant ($U = 33$, $p = 0.15$).

The CL was calculated for the number of Words/Conv% with equation [2]: $Z = 0.31$ implying $CL = 0.7$, implying that The probability that a randomly selected UnF NL P speaker will produce more Words/Conv% than a randomly selected F NL P speaker is 70%; a medium sized effect (large effect boundary: $CL = 0.71$).

By using the same equation for the AD subjects ($U = 19$, $p = 0.39$), we computed a $CL = 0.65$, $Z = 0.35$ implying that the probability that a randomly selected UnF NL AD speaker will produce more Words/Conv% than a randomly selected F NL AD speaker is 65%; also a medium effect.

Speaker Number	F NL P	Speaker Number	UnF NL P
1	*23.47*	*1*	*26.8*
2	*23.41*	*2*	*48.16*
3	*15.07*	*3*	*30.1*
4	29.02	4	36.8
5	24.04		
6	74.34		
7	5.13	7	8.33
8	25.67	8	34.78
9	12.99		
10	31.27	10	21.68
11	28.75	11	49.4
12	30.41	12	69.69

Table 37 Number of Words/Conv% (patient study). Speaker 4 to 12 display the results for the AD subjects

Number of Overlaps

Tables 38 and 39 show an overview of the descriptive statistics and Table 40 of the individual results.

Familiarity	Mean	StDev	Median	Min	Max
F NL P	16.67	10.43	15.5	2	39
UnF NL P	11.22	7.63	12	0	26

Table 38 Descriptive statistics for the number of Overlaps (patient study)

Familiarity	Mean	StDev	Median	Min	Max
F NL AD	16	11.81	14	2	39
UnF NL AD	10.33	5.89	12.5	0	16

Table 39 Descriptive statistics for the number of Overlaps (AD subjects only)

Speaker Number	F NL P		Speaker Number	UnF NL P	
1	*25*	*(34)*	*1*	*10*	*(19)*
2	*17*	*(33)*	*2*	*26*	*(59)*
3	*14*	*(27)*	*3*	*3*	*(7)*
4	39	(72)	4	16	(26)
5	18	(36)			
6	2	(4)			
7	6	(6)	7	0	(3)
8	21	(48)	8	13	(30)
9	5	(12)			
10	14	(26)	10	7	(12)
11	12	(24)	11	12	(29)
12	27	(51)	12	14	(34)

Table 40 Number of Overlaps/Conv. Total number of Overlaps/Conv are shown in parenthesis. Speaker 4 to 12 display the results for the AD subjects

The means%, StDevs% and medians% of the number of Overlaps/total number of Overlaps% for F NL P data and for the UnF NL P group is shown in Table 41.

Table 42 displays the results for the F NL AD and UnF NL AD percentages. For both, F NL AD and UnF NL AD subjects the means% and medians% were lower than for the F NL P and UnF NL P percentage data.

Table 43 shows that only two of nine recording-pairs showed a higher percentage in the UnF conversations (speakers 4 and 10).

Familiarity	Mean%	StDev%	Median%
F NL P	56.11	15.84	51.69
UnF NL P	42.81	17.77	43.33

Table 41 Descriptive statistics for the number of Overlaps/total number of Overlaps as % (patient study)

Familiarity	Mean%	StDev%	Median%
F NL AD	55.15	17.36	50
UnF NL AD	40.96	21.95	42.36

Table 42 Descriptive statistics for the number of Overlaps/total number of Overlaps as % (AD subjects only)

Speaker Number	F NL P	Speaker Number	UnF NL P
1	*73.53*	*1*	*52.63*
2	*51.52*	*2*	*44.07*
3	*51.85*	*3*	*42.86*
4	54.17	4	61.54
5	50		
6	50		
7	100	7	0
8	43.75	8	43.33
9	41.67		
10	53.85	10	58.33
11	50	11	41.38
12	52.94	12	41.18

Table 43 Number of Overlaps/total number of Overlaps% (patient study). Speaker 4 to 12 display the results for the AD subjects

We tested the normality of the distribution of the means% for the number of Overlaps/total number of Overlaps% for the F NL P and UnF NL P groups using a Shapiro-Wilk test.
F NL P and UnF NL P percentage data were not normally distributed with F NL P: W = 0.69, p = 0.001 and with UnF NL P: W = 0.77, p = 0.01. Proceeding with the Mann-Whitney U test, the result did not show a significant difference in the sum of the ranks of the two data sets (U = 31, p = 0.1). CL was calculated for the number of Overlaps/total number of Overlaps% with equation [2]; Z = 0.29 and CL = 0.71, such that the probability that a randomly selected F NL P speaker produces a greater number of Overlaps than a randomly selected UnF NL P speaker is 71% which may be considered a large effect.
Further, we computed CL for the F NL AD and UnF NL AD subjects, too. By using equation [2] (U = 37, p = 0.24), we found a CL = 0.69 (Z = 0.31). The probability that a randomly selected F NL AD subject initiates more Overlaps/total number of Overlaps% than a randomly selected UnF NL AD speaker is 69%; a medium sized effect.

We further compared the number of Overlaps/Conv% for the NL P data.
Tables 44 and 45 display the percentage data for the number of Overlaps/Conv% for the NL P and NL AD groups. It can be seen that the mean and median percentages were very close and that the UnF NL AD and F NL AD means% were lower than the means% of the overall patients' results.

Familiarity	Mean%	StDev %	Median %
F NL P	2.26	0.77	2.48
UnF NL P	2.63	1.38	2.76

Table 44 Descriptive statistics for the number of Overlaps/Conv as % (patient study)

Familiarity	Mean%	StDev%	Median%
F NL AD	2.22	0.85	2.47
UnF NL AD	2.59	1.58	2.79

Table 45 Descriptive statistics for the number of Overlaps/Conv as % (AD subjects only)

The directly comparable individual results (Table 46) show that in six out of nine F-UnF comparisons a higher percentage was observed for the UnF condition than for the F condition (speakers 1, 2, 3, 7, 10 and 11).

To see whether the difference in the means of the number of Overlaps/Conv% was statistically significant or not, we applied the Two Sample t-test, as we did find normal distribution for the F NL P percentage data ($W = 0.93$, $p = 0.38$) and the UnF NL P percentage data ($W = 0.97$, $p = 0.93$). The Two Sample t-test test showed that the difference in the means for the percentage of Overlaps/Conv% was not significant, with $t(19) = -0.79$, $p = 0.44$.

To calculate CL, we applied equation [1]. The effect size $Z = 0.23$ implied a $CL = 0.59$. The probability that a randomly selected UnF NL P speaker produces a greater number of Overlaps/Conv% than a randomly selected F NL P speaker is 59%. The CL effect size was considered to be small.

By using the same equation for the AD subjects, we have calculated $Z = 0.21$ and a $CL = 0.58$. The probability that a randomly selected UnF NL AD speaker produces a greater number of Overlaps/Conv% than a randomly selected F NL AD speaker is 58%; a small sized effect.

Speaker Number	F NL P	Speaker Number	UnF NL P
1	*2.48*	*1*	*2.76*
2	*2.93*	*2*	*3.82*
3	*1.74*	*3*	*4.75*
4	2.85	4	0
5	2.47		
6	1.31		
7	1.23	7	2.69
8	2.57	8	1.9
9	1.3		
10	2.7	10	2.88
11	1.83	11	3.34
12	3.7	12	1.53

Table 46 Number of Overlaps/Conv% (patient study). Speaker 4 to 12 display the results for the AD subjects

Number of Confirmations

Table 47 and 48 summarise the descriptive statistics for NL P and NL AD speakers respectively.

Familiarity	Mean	StDev	Median	Min	Max
F NL P	5.92	5.04	5	0	18
UnF NL P	4	2.83	4	0	9

Table 47 Descriptive statistics for the number of Confirmations (patient study)

Familiarity	Mean	StDev	Median	Min	Max
F NL AD	5.11	3.79	6	0	12
UnF NL AD	4	3.34	4	0	9

Table 48 Descriptive statistics for the number of Confirmations (AD subjects only)

The number of Confirmations for each conversation is displayed in Table 49. The number in parenthesis is the ratio of the number of Confirmations to the total number of Overlaps expressed as a percentage for each speaker (F NL P and UnF NL P). Again, looking at the individual and directly comparable results (in *italic*) of the F NL P data vs. the UnF NL P percent data, six out of nine recording-pairs have a higher percentage under the UnF condition (speakers 2, 3, 4, 10, 11 and 12).

Speaker Number	F NL P		Speaker Number	UnF NL P	
1	*18*	*(72)*	*1*	*4*	*(40)*
2	*3*	*(17.65)*	*2*	*6*	*(23.08)*
3	*4*	*(28.57)*	*3*	*2*	*(66.67)*
4	12	(30.77)	4	5	(31.25)
5	6	(33.33)			
6	1	(50)			
7	2	(33.33)	7	0	(0)
8	6	(28.57)	8	3	(23.08)
9	0	(0)			
10	4	(28.57)	10	6	(85.71)
11	7	(58.33)	11	9	(75)
12	8	(29.63)	12	1	(64.29)

Table 49 Number of Confirmations. Percentages are shown in parenthesis (patient study). Speaker 4 to 12 display the results for the AD subjects

The descriptive statistics for number of Confirmations% of the NL P and NL AD subjects are summarised in Table 50 and 52.

Familiarity	Mean%	StDev%	Median%
F NL P	34.23	18.67	30.2
UnF NL P	45.45	28.72	40

Table 50 Descriptive statistics for the number of Confirmations as % (patient study)

Familiarity	Mean%	StDev%	Median%
F NL AD	32.5	16.1	30.77
UnF NL AD	46.56	33.49	47.77

Table 51 Descriptive statistics for the number of Confirmations as % (AD subjects only)

We have analysed the difference (11.22%) between the F and UnF mean percentage data statistically for the patient group. First, we calculated the distribution regarding normality by using the Shapiro-Wilk normality test. For both, F NL P ($W = 0.91$, $p = 0.24$) and UnF NL P ($W = 0.95$, $p = 0.67$). We could assume normality. We continued by applying a Two Sample t-test. The result did not show significant difference in the mean percentages, with $t(19) = -1.09$, $p = 0.29$.

To evaluate CL, we used equation [1]. For the number of Confirmations%, the probability that a randomly selected UnF NL P speaker shows a higher number of Confirmations% than a randomly selected F NL P speaker is 63% (Z = 0.33, CL = 0.63); a medium sized effect.
For the AD percentages, we have computed a Z = 0.38 implying CL = 0.65 by using equation [1]. The probability that a randomly selected UnF NL AD speaker produces a greater number of Confirmations% than a randomly selected F NL AD speaker is 65%; again a medium sized effect.

Number of Predictions

Table 52 summarises the descriptive statistics for the NL P subjects regarding the number of Predictions.

Familiarity	Mean	StDev	Median	Min	Max
F NL P	5.25	4.9	3	1	15
UnF NL P	3.22	1.92	4	0	5

Table 52 Descriptive statistics for the number of Predictions (patient study)

The F NL AD and UnF NL AD participants results are displayed in Table 53. Considering only the AD speakers, the results showed that the F NL AD partners, by themselves, had a lower mean than the AD+FTD data combined (F NL P). The opposite was observed for the UnF NL AD subjects: the UnF NL AD interlocutors produced a higher number of Predictions on average than the UnF NL P group.

Familiarity	Mean	StDev	Median	Min	Max
F NL AD	4.67	4.42	2	1	14
UnF NL AD	3.33	1.75	4	0	5

Table 53 Descriptive statistics for the number of Predictions (AD subjects only)

By looking at the percentage (in parenthesis) in Table 54, we can see that three out of nine conversation-pairs have a higher occurrence of overlaps under the UnF condition (speakers 10, 11 and 12).

Speaker Number	F NL P		Speaker Number	UnF NL P	
1	*15*	*(60)*	*1*	*5*	*(50)*
2	*3*	*(17.65)*	*2*	*4*	*(15.38)*
3	*3*	*(21.43)*	*3*	*0*	*(0)*
4	14	(35.9)	4	5	(31.25)
5	3	(16.67)			
6	1	(50)			
7	2	(33.33)	7	0	(0)
8	9	(42.86)	8	4	(30.77)
9	2	(40)			
10	2	(14.29)	10	4	(57.14)
11	2	(16.67)	11	3	(25)
12	7	(25.93)	12	4	(28.57)

Table 54 Number of Predictions. Percentages are shown in parenthesis (patient study). Speaker 4 to 12 display the results for the AD subjects

Table 55 and 56 summarise the results for the NL P and NL AD subjects. In particular percentage means for the F NL P and F NL AD are very close; a difference of only 0.6%. In contrast to the mean percentages, the medians% are rather higher for the F NL AD data (difference = 3.7%) than for the F NL P data.

Familiarity	Mean%	StDev%	Median%
F NL P	31.23	14.89	29.63
UnF NL P	26.46	19.58	28.57

Table 55 Descriptive statistics for the number of Predictions as % (patient study)

Familiarity	Mean%	StDev%	Median%
F NL AD	30.63	12.88	33.33
UnF NL AD	28.79	18.2	29.67

Table 56 Descriptive statistics for the number of Predictions as % (AD subjects only)

We analysed the number of Predictions% for F NL P and UnF NL P speakers to detect whether difference in the mean percentage data was statistically significant or not. The number of Predictions% of the F NL P group was normally distributed ($W = 0.92$, $p = 0.29$) as were the UnF NL P group percentages ($W = 0.93$, $p = 0.53$). We applied a Shapiro-Wilk test to examine normality.

We proceeded using a Two Sample t-test. The results showed no significant difference between the mean percentages, with $t(19) = 0.64$, $p = 0.53$.

We have computed the effect size by using equation [1] for normal distributed data; Z = 0.19 and CL = 0.58. The probability that a randomly selected F NL P speaker shows a higher number of Predictions% than a randomly selected UnF NL P speaker is 58%. The outcome was considered to be a small sized effect.

For the AD subjects, we have used equation [1] as well and found Z = 0.08 and CL = 0.53. The probability that a randomly selected F NL AD speaker produces a greater number of Predictions% than a randomly selected UnF NL speaker is 53%. No effect was found.

Number of FTT

Table 57 and 58 summarise the descriptive results for all patients and for the AD subjects respectively. The AD speakers showed lower means than the corresponding NL P data. However, the median was identical for the F NL P data and the F NL AD data and the numbers of FTT compared. The individual results are presented in Table 59.

Familiarity	Mean	StDev	Median	Min	Max
F NL P	10	6.12	10.5	1	21
UnF NL P	7.44	5.41	8	0	17

Table 57 Descriptive statistics for the number of FTT (patient study)

Familiarity	Mean	StDev	Median	Min	Max
F NL AD	9.33	6.52	10	1	21
UnF NL AD	6.83	4.71	8.5	0	11

Table 58 Descriptive statistics for the number of FTT (AD subjects only)

Speaker Number	F NL P		Speaker Number	UnF NL P	
1	*16*	*(64)*	*1*	*7*	*(70)*
2	*14*	*(82.35)*	*2*	*17*	*(65.38)*
3	*6*	*(42.86)*	*3*	*2*	*(66.67)*
4	21	(53.85)	4	8	(50)
5	11	(61.11)			
6	1	(50)			
7	3	(50)	7	0	(0)
8	15	(71.43)	8	11	(84.62)
9	3	(60)			
10	10	(71.43)	10	2	(28.57)
11	7	(58.33)	11	9	(75)
12	13	(48.15)	12	11	(78.57)

Table 59 Number of FTT. Percentages are shown in parenthesis. Speaker 4 to 12 display the results for the AD subjects

The means%, StDevs% and medians% of the NL P and NL AD subjects are summarised in Table 60 and 62. F NL AD and UnF NL AD speakers showed lower percentage FTT for the means and medians than the corresponding F NL P and UnF NL P data. Specifically, the difference between the UnF NL P and the UnF NL AD data was larger (mean% difference = 4.86%) than the difference between the F NL P and F NL AD results (mean% difference = 1.2%).

Familiarity	Mean%	StDev%	Median%
F NL P	59.46	11.48	59.17
UnF NL P	57.65	27.36	66.67

Table 60 Descriptive statistics for the number of FTT as % (patient study)

Familiarity	Mean%	StDev%	Median%
F NL AD	58.26	8.78	58.33
UnF NL AD	52.79	33.32	62.5

Table 61 Descriptive statistics for the number of FTT as % (AD subjects only)

The percentage data in Table 59 shows higher numbers for the F P condition in only four out of nine pairs (speakers 2, 4, 7 and 10).

For our evaluation, we have looked at the difference between the F NL P and UnF NL P percentage mean for the category FTT using a Two Sample t-test, as we could assume normality

for the F NL P and the UnF NL P percentages (for F NL P: W = 0.96, p = 0.81 and for UnF NL P: W = 0.85, p = 0.08). The difference in the means% was not significant, with t(19) = 0.21, p = 0.84.
We have computed the CL by applying equation [1]. Z = 0.06 and CL = 0.52, which means that the probability that a randomly selected F NL P speaker shows a higher number of FTT% than a randomly selected UnF NL P speaker is 52%. No effect was found.
For the AD data%, we have computed a Z = 0.16, with CL = 0.56 using equation [1]. The probability that a randomly selected F NL AD speaker produces a greater number of FTT% than a randomly selected UnF NL AD speaker is 56%; a small sized effect.

Number of FaiTT

The difference of the means and medians between F NL P and F NL AD and between UnF NL P and UnF NL AD data were minimal (Tables 62 and 63).

Familiarity	Mean	StDev	Median	Min	Max
F NL P	6.67	5.05	5.5	1	18
UnF NL P	3.78	3.03	3	0	9

Table 62 Descriptive statistics for the number of FaiTT (patient study)

Familiarity	Mean	StDev	Median	Min	Max
F NL AD	6.67	5.7	5	1	18
UnF NL AD	3.5	2.74	3	0	8

Table 63 Descriptive statistics for the number of FaiTT (AD subjects only)

Table 64 summarises the results for each recording. The tendency for the nine directly comparable NL P speakers was that six out of nine conversation-pairs had a higher percentage for FaiTT overlaps in the F condition (speakers 1, 3, 7, 8, 11 and 12). The percentages for the NL P and NL AD subjects are summarised in Table 65 and 66. Comparing the UnF NL P and the UnF NL AD percentages for the median, the difference is large, with 6.78%, The intra difference between F NL P and UnF NL P (10.84%) and between F NL AD and UnF NL AD (18.45%) median% results is highly different, too.

Speaker Number	F NL P		Speaker Number	UnF NL P	
1	*9*	*(36)*	*1*	*3*	*(30)*
2	*3*	*(17.65)*	*2*	*9*	*(34.62)*
3	*8*	*(57.14)*	*3*	*1*	*(33.33)*
4	18	(46.15)	4	8	(50)
5	7	(38.89)			
6	1	(50)			
7	3	(50)	7	0	(0)
8	6	(28.57)	8	2	(15.38)
9	2	(40)			
10	4	(28.57)	10	5	(71.43)
11	5	(41.67)	11	3	(25)
12	14	(51.85)	12	3	(21.43)

Table 64 Number of FaiTT. Percentages are shown in parenthesis. Speaker 4 to 12 display the results for the AD subjects

Familiarity	Mean%	StDev%	Median%
F NL P	40.54	11.48	40.84
UnF NL P	31.24	20.45	30

Table 65 Descriptive statistics for the number of FaiTT as % (patient study)

Familiarity	Mean%	StDev%	Median%
F NL AD	41.74	8.78	41.67
UnF NL AD	30.54	25.79	23.22

Table 66 Descriptive statistics for the number of FaiTT as % (AD subjects only)

We were interested in whether we could find a significant difference between the F NL P and the UnF NL P percentage data or not. The Shapiro-Wilk normality test revealed a normal distribution for the UnF NL P percentage data ($W = 0.96$, $p = 0.8$) and for the F NL P data, with $W = 0.96$, $p = 0.81$. Therefore, we continued the analysis by using a Two Sample t-test. The difference between the mean percentages of F NL P and UnF NL P data was not significant ($t(19) = 1.32$, $p = 0.2$). The effect size for the independent samples was $Z = 0.4$ (equation [1]) and the CL was accordingly 0.66. Considering the means%, we can say that the probability that a randomly selected F NL P speaker shows a higher number of FaiTT% than a randomly selected UnF NL P speaker is 66%. We found a medium sized effect.

For the F NL AD and the UnF NL AD speakers we calculated Z = 0.41 (CL = 0.66) by using equation [1]. The probability that a randomly selected F NL AD speaker produces a greater number of FaiTT% than a randomly selected UnF NL AD speaker is 66%. As for the NL P speakers, we found a medium sized effect for the NL AD subjects.

Number of FaiTTC

An overview of mean, StDev, median, minimum and maximum values of the NL P speakers is given in Table 67.

The results of the AD subjects are summarised in Table 68. F NL AD and UnF NL AD participants initiated on average fewer FaiTTC compared to the overall patient data.

Familiarity	Mean	StDev	Median	Min	Max
F NL P	3.92	3.42	3.5	1	10
UnF NL P	2.33	2.45	1	0	8

Table 67 Descriptive statistics for the number of FaiTTC (patient study)

Familiarity	Mean	StDev	Median	Min	Max
F NL AD	3.78	3.6	3	0	10
UnF NL AD	1.83	1.47	1.5	0	4

Table 68 Descriptive statistics for the number of FaiTTC (AD subjects only)

Table 69 and 70 summarise the results as a percentages. The UnF NL AD initiated, on average, fewer FaiTTC if either the mean or median percentages were compared to the overall patient data including the FTD patients.

Familiarity	Mean%	StDev%	Median%
F NL P	22.16	14.96	23.54
UnF NL P	19.27	14.42	16.67

Table 69 Descriptive statistics for the number of FaiTTC as % (patient study)

Familiarity	Mean%	StDev%	Median%
F NL AD	22.16	16.04	21.43
UnF NL AD	16.56	15.52	12.18

Table 70 Descriptive statistics for the number of FaiTTC as % (AD subjects only)

Again, we directly compared the five subjects, which we recorded twice and in each condition, the percent numbers show that five out of nine conversation-pairs had a greater overlap rate under the F P condition (speakers 1, 4, 8, 11 and 12) (Table 71).

Speaker Number	F NL P		Speaker Number	UnF NL P	
1	*8*	*(32)*	*1*	*1*	*(10)*
2	*1*	*(5.88)*	*2*	*8*	*(30.77)*
3	*4*	*(28.57)*	*3*	*1*	*(33.33)*
4	10	(25.64)	4	4	(25)
5	3	(16.67)			
6	1	(50)			
7	0	(0)	7	0	(0)
8	4	(19.05)	8	1	(7.69)
9	0	(0)			
10	3	(21.43)	10	3	(42.86)
11	4	(33.33)	11	2	(16.67)
12	9	(33.33)	12	1	(7.14)

Table 71 Number of FaiTTC. Percentages are shown in parenthesis (patient study). Speaker 4 to 12 display the results for the AD subjects

We evaluated the significance of the difference of the means% by using the Two Sample t-test as the UnF NL P percentage of the number of FaiTTC overlaps (UnF: $W = 0.95$, $p = 0.67$) and the F NL P data (F: $W = 0.95$, $p = 0.62$) were normally distributed.,. The Two Sample t-test did not show significant difference in the means%, with $t(19) = 0.44$, $p = 0.66$.

To compute Z and the CL, we applied equation [1]. Based on this calculation, we can say that the probability that a randomly selected F NL P speaker shows a higher occurrence of FaiTTC% than a randomly selected UnF NL P speaker is 56% ($Z = 0.14$ and $CL = 0.56$); a small sized effect.

For the F NL AD and UnF NL AD subjects, we computed $Z = 0.25$ ($CL = 0.6$) by applying equation [1]. The probability that a randomly selected F NL AD speaker produces a greater number of FaiTTC% overlaps than a randomly selected UnF NL AD speaker is 60%, which is considered to be a small effect.

Number of Others

The mean, StDev, median, minimum and maximum numbers for the NL P and NL AD subjects are displayed in Table 72and 73. The difference between UnF NL P and UnF NL AD subjects is large, with a difference in the means of 0.77.

Familiarity	Mean	StDev	Median	Min	Max
F NL P	1.83	1.53	2	0	4
UnF NL P	1.44	2.24	1	0	7

Table 72 Descriptive statistics for the number of Others (patient study)

Familiarity	Mean	StDev	Median	Min	Max
F NL AD	2	1.66	2	0	4
UnF NL AD	0.67	0.82	0.5	0	2

Table 73 Descriptive statistics for the number of Others (AD subjects)

This difference is also apparent in the percentage data as can be seen in Table 74 and Table 75. The percentage difference between the UnF NL P and the UnF NL AD percent data is 3.66%. The percent difference between the F NL P and the F NL AD data is smaller at 2.13%.

Familiarity	Mean%	StDev%	Median%
F NL P	15.08	16.5	11.01
UnF NL P	8.32	9.86	7.14

Table 74 Descriptive statistics for the number of Others% (patient study)

Familiarity	Mean%	StDev%	Median%
F NL AD	17.21	18.42	10.26
UnF NL AD	4.66	5.41	3.57

Table 75 Descriptive statistics for the number of Others% (AD subjects)

Table 76 shows that the FTD patients (speaker 1 to 3) were mainly responsible for the difference between the UnF NL P and the UnF NL AD data. However, as mentioned in the beginning of this chapter, the difference in the means% between UnF NL P and UnF NL AD was not significant.

Speaker Number	F NL P		Speaker Number	UnF NL P	
1	*0*	*(0)*	*1*	*2*	*(20)*
2	*2*	*(11.76)*	*2*	*7*	*(26.92)*
3	*2*	*(14.29)*	*3*	*0*	*(0)*
4	4	(10.26)	4	2	(12.5)
5	4	(22.22)			
6	0	(0)			
7	3	(50)	7	0	(0)
8	0	(0)	8	0	(0)
9	2	(40)			
10	0	(0)	10	0	(0)
11	3	(25)	11	1	(8.33)
12	2	(7.41)	12	1	(7.14)

Table 76 Number of Others. Percentages are shown in parenthesis (patient study). Speaker 4 to 12 display the results for the AD subjects

Looking at Table 76 and the individuals we have recorded under both conditions (*italic*), it can be seen that four out of nine recording-pairs showed a higher outcome for overlaps in the category Others% under the F condition (speakers 3, 7, 11 and 12). However, two F/UnF pairs showed no overlaps for two NL P speakers (speakers 8 and 10).

We tested the difference of the percentage number of Others to see whether F NL P speakers produced statistically significantly more overlaps of the category Others than the UnF NL P speakers as the means% and medians% suggest.

Shapiro-Wilk normality tests revealed that F NL P and UnF NL P mean percentages were both normally distributed, with F P NL: W = 0.86, p = 0.049 (0.05) and UnF NL P: W = 0.84, p = 0.06. A Two Sample t-test did not show significant differences in the mean percentages ($t(19) = 1.09$, $p = 0.29$).

Further, we wanted to know the CL for the percent data by using equation [1]. We have computed that the probability that a randomly selected F NL P speaker shows a higher number of Others% than a randomly selected UnF NL P speaker is 64% (Z = 0.35 and CL = 0.64). We found a medium effect.

We found Z = 0.65 for the F NL AD and UnF NL AD speakers by using equation [1] and accordingly a CL = 0.74. The probability that a randomly selected F NL AD speaker produces a greater number of Others% than a randomly selected UnF NL AD speaker is 74%, a large sized effect.

Distribution of Categorical Percentages of the number of Overlaps

After considering all the number and percentage data above, we calculated the portion of the total number of Overlaps% per category (Table 77 and 78). As we have marked each overlap most of the time as two or even three samples of a category, the numbers of Confirmations%, Predictions% and Others% does not sum up to 100%. However, the categories FTT and FaiTT result approximately in 100% as an overlap had to be either Fully succeeded or Failed. One AD patient did not overlap at all and therefore we counted his/her proportion as 0%.

For the P NL data, the category FTT had the greatest proportion of the number of Overlaps whereas the category Others was the lowest proportion. The categories Confirmations and FaiTT had approximately equal mean proportions. Considering the medians%, number of FTT% was large, with a value over 60% and the category Others was the smallest.

The AD NL data (Table 78) shows that the highest mean% was observed for the category FTT and the lowest for the number of Others%. The number in the categories Confirmations% and FaiTT% were close to each other.

The medians% showed the highest value for the number of FTT%. The categories Confirmations and Predictions had a similar median% with approximately 30% occurrence each.

	Confirmations%	Predictions%	FTT%	FaiTT%	FaiTTC%	Others%
Mean%	39.04	29.18	58.68	36.56	20.92	12.18
SD%	23.54	16.77	19.30	16.19	14.44	14.15
Median%	31.25	28.57	61.11	36	21.43	8.33

Table 77 Ratio of categories% of the number of Overlaps (patient study)

	Confirmations%	Predictions%	FTT%	FaiTT%	FaiTTC%	Others%
Mean%	38.12	29.89	56.07	37.26	19.92	12.19
SD%	24.49	14.63	21.17	17.72	15.53	15.64
Median%	31.25	30.77	58.33	40	19.05	7.41

Table 78 Ratio of categories% of the number of Overlaps (AD study only)

8.2 Discussion

Following our initial research interests (Chapter 4 and above) are the following:

1. Whether the chosen categories (Confirmations, Predictions, FTT, FaiTT, FaiTTC and Others) are measurable or not in conversations including dementia patients.
2. Whether there was a Familiarity effect in the speech of people with dementia.

In more detail, we now consider our interest in the conversational behaviour, expressed here in the occurrence of overlaps and the findings for the overlap categories, and our question about the existence of a Familiarity effect in speech in dementia. As mentioned above, we will report only the percentages of the significant difference in the means% or medians% of the overall patient data. The reason for this was explained and justified by the fact that AD+FTD and AD-FTD percentages were not significantly different. To achieve greater statistical power, we have pooled both groups.

As we formulated expectations about AD NL speakers in Chapter 6, we will further consider the descriptive statistics the data for AD alone. Since the aim is to reveal differences between AD and healthy data, we think it would be contradictory to our research questions to discuss the overall patient data in detail here as well.

<u>Suitability of the chosen categories for characterising AD speech and measurability</u>

In order to address the interest in the AD NL speakers' behaviour and the appropriateness of measuring the overlapping behaviour according to our categories, we have described the distribution of the number of overlaps of the total number of Overlaps%.

Table 78 displays that the category Confirmations, which allows conclusion about the ability of processing input and intention simultaneously, is strongly represented with a percentage of almost 40%. Our data show that AD NL speakers raised Confirmations overlaps more often than they used Predictions overlaps. Giving feedback (Confirmations) during a conversation is a routinized, simply retrievable and accepted tool regarding overlap behaviour (Seedhouse, 2004) and therefore likely to be a preferred action in AD speech ((Rousseaux et al., 2010). Only two patients did not use Confirmations overlaps at all in their conversations.

The ability to predict an upcoming possible TRP or the ability to analyse syntactic structures in order to continue the current speech for the purpose of taking the floor was observed in all AD speakers except for one. This speaker did not overlap the conversational (UnF NL AD) partner at all, and only spoke 18 Words/Conv out of a total number of 216 Words/Conv.

Five conversations showed no overlaps in the category Others, all other patients overlapped in this category at least once.

Categories describing the strategic behaviour in terms of completing an intentional overlap revealed that the AD NL speakers succeeded in turn-taking 56% of the time. The percentage of FTT and FaiTT differed by 19% of the total number of Overlaps, with the number of FTT% being higher than the number of FaiTT%. An intended turn-taking overlap was completed half of the time, showing that AD NL speakers gave up their attempt of turn-taking quite often.

We were able to measure the extent of success for the AD NL speakers regarding turn-taking as a result of overlapping. Further, we showed that the ability to confirm current speech and predict upcoming TRPs is still recognizable in our AD data.

We found examples of all our overlap categories in the AD conversations demonstrating the suitability of our measurements in order to analyse AD speech.

Confirmations overlaps are a dominant feature in AD speech in order to complete the task and seem characteristic of AD speech. However, not all speakers confirmed at least once. In total, two of 15 speakers did not give feedback by using overlaps. This overlapping behaviour might be related to the AD patients' repetitional tendencies and their perseverate performance (Murdoch et al., 1987). The simpler the structure of an utterance, the shorter the simultaneous processing of input and the intention to overlap in order to take the turn. Achieving turn-taking can easily be done by initiating an overlap through feedback as it is an accepted tool to take the floor.

In the category Predictions, only one speaker did not initiate an overlap demonstrating that, as well as feedback during conversations, the predictive ability of current speech is also a method used in order to finish the task in AD speech. The fewer occurrence of Others overlaps demonstrates that the categories Confirmations and Predictions are good representatives for dominant conversational behaviour regarding turn-taking.

As we found a difference between Full and Failed turn-takings, we conclude that these categories are adequate measures in order to characterise the conversational behaviour regarding their organisation and execution of planned overlaps of our AD NL subjects.

Perhaps due to our small sample size (n (recordings) = 21: F NL P = 12, UnF NL P = 9), we did not see a significant difference for the means% and medians% of the F NL AD and UnF NL AD data. However, we found promising results regarding CL effect size.

Familiarity effect

For the patient (AD) study, we analysed ten variables statistically: number of Words/Conv, number of Words/Conv%, number of Overlaps/Conv%, number of Overlaps/total number of Overlaps%, number of Confirmations%, number of Predictions%, number of FTT%, number of FaiTT%, number of FaiTTC% and number of Others%. However, as we have calculated with percentages rather than with numbers, we will report only the means% and medians%.

By looking at the percent data, the number of Words/Conv% showed that the UnF NL AD subjects were more involved in the conversations than AD subjects speaking with a familiar conversational partner. The difference between UnF NL AD subjects and F NL AD speakers was a medium sized effect.

A similar observation was made for the number of Overlaps/Conv% where the UnF NL AD speakers initiated more overlaps than the F NL AD participants. However, the effect was small. This outcome is in agreement with the findings of (Bortfeld et al., 2001). They noted that disfluencies (overlaps) in conversations increase if heavier demands are placed on the speech planning system. Planning and memorization becomes difficult for AD patients (Guinn and Habash, 2012) and we propose that adapting to an unfamiliar person's conversational behaviour is especially challenging for AD subjects and result in an increase of overlapping speech.

Comparing the F NL AD and the UnF NL AD results regarding the number of Overlaps/total number of Overlaps%, the F NL AD subjects overlapped more often than the UnF NL AD patients. We found a medium sized effect; a CL of 0.69. Within a conversation with a familiar lead, it seemed that F NL AD subjects were more confident to initiate overlaps than they were with an UnF conversational partner. Based on the literature, it may also be that F NL AD subjects were less inhibited in showing their confusion to F interlocutors, which may be the cause of an overlap (Ripich et al., 1991).

In Chapter 6, we predicted higher numbers for F NL AD subjects than for UnF NL AD speakers in the categories Predictions, FTT and FaiTTC. The following section will show if our assumptions were correct and discuss our previous findings:

In line with our expectations for the category Confirmations, UnF NL AD speakers overlapped more often than F NL AD subjects. The CL indicated an increased probability in the UnF condition compared to the F condition of using Confirmations (CL = 0.65) with a medium effect size. Spontaneity of speech is highly affected in AD (Guinn and Habash, 2012), and Confirmations-overlaps seem to be a preferred initiation strategy as we observed in our data. The deficit of planning and execution of more complex speech which involves the ability to interpret the other person's intention (ToM) and syntactical structuring, may result in an increased use of feedback (Confirmations) in the UnF condition as the patients tended to participate more in a conversation with a stranger. In other words, the increased number of Words/Conv% led to the assumption that UnF AD NL speakers were highly engaged, but as we know from the literature, AD speakers are aware of their conversational deficits (Jones et al., 2016; Ripich et al., 1991) and they may have used an increased use of simple Confirmations overlaps to hide their limitations.

The percentage of Predictions was greater for the F NL AD subjects than for the UnF NL AD speakers. The CL implied no effect of increased probability that an F NL AD speaker used a higher percentage of Predictions than an UnF NL speaker. We predicted a larger number of Predictions% for the F NL AD speakers and our data support this, but the difference between F NL AD and UnF NL AD was small. The attention ability, being expressed in predicting upcoming TRPs and following the syntactical structure in order to continue the current speech before it is completed, might have been limited in the AD subjects' speech processing in general (Guinn and Habash, 2012).

We predicted a higher percentage mean in the category FTT% for the F NL AD subjects than for the UnF NL AD subjects due to their stronger confidence that the partner will accept an initiated FTT more readily than an UnF partner who is not familiar with the AD patient's language and conversational behaviour. The means% supported this assumption. However, the medians% were higher for the UnF NL AD speakers. Considering a small sized effect of CL = 0.56, we can say that our hypothesis was supported, but not strongly.

We found a higher mean FaiTT% for the F NL AD subjects than for the UnF NL AD speakers. The CL = 0.66, a medium effect, supported the notion of an effect favouring the F NL AD group over the UnF NL AD group. This outcome is contrary to our assumption that UnF NL AD subjects are more often willing to stop their own speech in order follow the conversation and the instructions. Supporting our observations, we note the conclusion of Ripich et al. (1991) that AD patient's understanding of their own confusion and their knowledge of their familiar partner is more likely to contribute to the efficiency of the conversation (finishing the task in less time).

In accordance with our assumption made earlier, the number of FaiTTC% is higher for the F NL AD subjects. A tendency towards a higher number of FaiTTC% in AD speech was confirmed by the CL = 0.6, though the effect was small. As stated by Ripich et al. (1991), AD patients use shorter utterances (Chapter 2.2), and we conclude therefore that the probability of a higher number of FaiTTC% due to its nature of being usually a short utterance (e.g. "Yes", "I understand" or "Go on"), especially completed feedback overlaps, in general is likely to occur. It seemed that our NL AD speakers were more confident in finishing their turns, though they did not take the turn fully, with a familiar partner.

The category Others had, for the AD data, a large effect (CL = 0.74). Our data revealed a higher number of Others% for the F NL AD subjects than for the UnF NL AD subjects. It is very difficult to provide arguments for this outcome as the category includes various parameters, e.g. laughter or onset sounds.

Our expectations failed for the categories FTT (median%) and FaiTT (mean% and median%). The AD speakers seemed to be more confident with familiar speakers if a frequent number of Overlaps is interpreted as an indicator for comfort in conversations (Yuan et al., 2007, 2006). We may deduce that the familiar partners (F L AD) showed a higher acceptance of overlapping their speech than the unfamiliar partners (UnF L AD).

Considering the descriptive statistics, greater differences between F NL AD and UnF NL AD subjects (> 5%) in the means% was found for the categories Confirmations (14.06%), FTT (5.47%), FaiTT (11.2%), FaiTTC (5.6%) and Others (12.55%).
We found a large sized effect for the number of Others, medium sized effects for the categories Confirmations and FaiTT and small sized effects for the number of FTT% and FaiTTC.
Further, we found medium sized effects for the number of Words/Conv%, Overlaps/total number of Overlaps% and small sized effects for the number of Words/Conv, number of Overlaps/Conv%.
A measureable CL effect may be taken as evidence for Familiarity as it confirms a tendency to favour one condition over the other.

Summary

We found examples of all overlap categories in the AD conversations demonstrating the suitability of our measurements in order to characterise AD speech.
Confirmations overlaps are a dominant feature in AD speech in order to complete the task and characteristic of AD speech. Only two of 15 speakers did not give Confirmations overlaps.
One speaker did not initiate an overlap of the category Predictions demonstrating that the predictive ability of current speech is a suitable method in order to analyse and describe differences AD speech as well as in healthy speech
We concluded that the categories Confirmations and Predictions are good representatives for dominant conversational behaviour regarding turn-taking.
Further, the greater difference between Full and Failed turn-takings showed that these categories are able to characterise the conversational behaviour with numbers regarding the organisation and execution of planned overlaps of our AD NL subjects.

The parameters which supported the existence of a Familiarity effect in AD subjects in our study were the number of Words/Conv, Words/Conv%, Overlaps/total number of Overlaps%, Confirmations%, FTT%, FaiTT%, FaiTTC% and Others%. We were not able to show a Familiarity effect for the number of Predictions%. This outcome shows that our categories are promising in terms of characterising and differentiating F NL AD and UnF NL AD speakers.
So on balance and by considering the outcome for the categories, we think that there is evidence for a Familiarity effect in our study

In the following section, the initial recording results will be compared with the AD data obtained by the second recording. Differences and changes in the AD data will be discussed afterwards.

8.3 AD Study - Second Recording

We performed a second recording session as we were interested in the progression of the disease and whether there would be a change in the number of Overlaps or not.

For the AD patients, two patients agreed to participate with their familiar partners a second time. Speaker 1 (male; age = 81) was recorded five months after the first session. The clinic documentation notes that Speaker 1 does not have any insight into his memory difficulties and has become more withdrawn and less spontaneous when in company (08/10/2014).
Speaker 2 (female; age = 83) was recorded a second time eight months after her first appointment. We were not able to record both speakers with an UnF L AD speaker due to organisational difficulties.

In the following we will present the result for these two speakers and provide a comparison between the first and second recording which should be considered with particular caution regarding the strength of its informative value. In Chapter 2.4, Chapter 5.2 (map task) and Chapter 7.1, we noted and observed that Familiarity does have an impact on healthy speech and we further found differences between the F NL and UnF NL condition in AD speech. Therefore, we expect limited information about changes over time for our AD speakers, as Familiarity is a strong differentiator for certain conversational behaviour regarding overlap. Nonetheless, we will report our findings in the following section for the NL AD subjects under the F condition.

<u>Number of Words/Conv</u>
The total number of Words/Conv are summarised in Table 79. For both conversations, we could observe a decrease in the numbers. A stronger decrease was found for the conversations including speaker 1.

Total number of Words/Conv	First recording	Second recording
Speaker 1 Conversation	518	418
Speaker 2 Conversation	728	502

Table 79 Total number of Words/Conv (NL AD + L AD).

This distribution of data was also observed in the calculated percentages. The results for each speaker are displayed in Table 80. Both speakers decreased their use of Words/Conv%, whereas speaker 1 showed a greater difference between the recordings (12.85%).

Number of Words/Conv	First recording	Second recording
Speaker 1	162 (31.27%)	77 (18.42%)
Speaker 2	175 (24.04%)	102 (20.32%)

Table 80 Number of Words/Conv (AD speakers). Percentages for the number of Words/Conv for speaker 1 and speaker 2 are shown in parenthesis.

Number of Overlaps/Conv

Table 81 shows the number of Overlaps for the NL AD speakers and the total number of Overlaps, considering the data of the conversational partner.

Number of Overlaps	First recording	Second recording
Speaker 1	14 (26)	4 (10)
Speaker 2	18 (36)	10 (16)

Table 81 Number of Overlaps/Conv. Total number of Overlaps are shown in parenthesis (L AD + NL AD)

As it is displayed in Table 82, speaker 1 decreased and speaker 2 increased their number of Overlaps/total number of Overlaps%.

Number of Overlaps/total Number of Overlaps	First recording	Second recording
Speaker 1	53.85%	40%
Speaker 2	50%	62.5%

Table 82 Percentages for the number of Overlaps/total number of Overlaps (AD speakers)

The individual results revealed a decrease of overlaps% for both speakers, with a greater difference in the percentage for speaker 1 (Table 83).

Number of Overlaps/Conv	First recording	Second recording
Speaker 1	2.7%	0.96%
Speaker 2	2.47%	1.99%

Table 83 Percentages for the number of Overlaps/Conv (AD speakers)

Number of Confirmations

Speaker 1 and 2 revealed a decrease in the number of Confirmations in the second session. As summarised in Table 84, speaker 1 decreased to zero, whilst speaker 2 increased her use of Confirmations%.

Number of Confirmations	First recording	Second recording
Speaker 1	4 (28.57%)	0 (0%)
Speaker 2	6 (33.33%)	5 (50%)

Table 84 Number and percentages for Confirmations (AD speakers)

Number of Predictions

Table 85 summarises the result for each speaker for the first and the second recording.

Number of Predictions	First recording	Second recording
Speaker 1	2 (14.29%)	1 (25%)
Speaker 2	3 (16.67%)	5 (50%)

Table 85 Number and percentages for Predictions (AD speakers)

Both speakers increased the percentage of Overlaps of the category Prediction, whereas speaker 2 differed with a greater difference (33.33%).

Number of FTT

Number of FTT	First recording	Second recording
Speaker 1	10 (71.43%)	4 (100%)
Speaker 2	11 (61.11%)	5 (50%)

Table 86 Number and percentages for FTT (AD speakers)

Table 86 shows that whilst speaker 1 increased the number of FTT% up to 100%, speaker 2 decreased the number of FTT% from 61.11% to 50%.

Number of FaiTT

Number of FaiTT	First recording	Second recording
Speaker 1	4 (28.57%)	0 (0%)
Speaker 2	7 (38.89%)	5 (50%)

Table 87 Number and percentages for FaiTT (AD speakers)

Table 87 displays a decrease in the number of FaiTT% for speaker 1 (28.57%) and an increase of the percentage of FaiTT for speaker 2 (difference = 10.11%).

Number of FaiTTC

The individual results, which are displayed in Table 88, show a strong decrease in the percentage for speaker 1 (difference = 28.57%) and a mild increase for speaker 2 (difference = 3.33%).

Number of FaiTTC	First recording	Second recording
Speaker 1	3 (28.57%)	0 (0%)
Speaker 2	3 (16.67%)	2 (20%)

Table 88 Number and percentages for FaiTTC (AD speakers)

Number of Others

Number of Others	First recording	Second recording
Speaker 1	0 (0%)	0 (0%)
Speaker 2	4 (22.22%)	2 (20%)

Table 89 Number and percentages for Others (AD speakers)

Whilst speaker 1 did not initiate any overlaps of the category Others% during the first and the second recording, speaker two decreased the number of Others% (2.22%) (Table 89).

8.4 Discussion

We conducted a second recording session and an analysis to check whether we could find a decrease of the number of Overlaps and particularly which categories are affected.

In Chapter 4, we assumed that we would find a decrease in the number of Overlaps as the abilities of planning and organising speech may become limited during the progression of the disease. We expected a decrease of overlapping behaviour, because patients may become less interested in being involved in speech and might reduce their turn taking (Ripich et al., 1991). However, as only two conversations per session were available for analysis, the findings should be treated with caution. We will here report only those measurements which showed either a decrease or an increase in the conversational behaviour for both, speaker 1 and speaker 2. Numbers. The percentages which revealed an increase for one speaker but not for the other or vice versa, will not be considered for this brief summary.

A decrease in the numbers for both speakers was found for:

1. Words/Conv

1. Overlaps/Conv

A decrease in the percentages for both speakers was found for:

1. Words/Conv
2. Overlaps/Conv
3. Others

An increase in the percentage for both speakers was found for:

1. Predictions

Speaker 2 had greater differences in the percent data than speaker 1 for the categories Others and Predictions.
Speaker 1 had greater differences between the first and second recording in his data than speaker 2 for the number of Words/Conv and the number of Overlaps/Conv as well as for the percentage number of Words/Conv and the percentage number for Overlaps/Conv .

We observed a decline in speech behaviour regarding the participation in the conversation. It seemed that the AD speakers were less able or motivated to contribute to the conversation on the second occasion. The reduced number of Overlaps/Conv% was consistent with this finding. The previously mentioned notes of the clinic support this observation of becoming more hesitant. The finding of decreased percentage may be due to the fact that over the progress of the disease, AD patients' speech is reduced to simpler speech (Romero and Kurz, 1996) and difficulties with recalling from long term memory appear (Blair et al., 2007; MacDonald et al., 2001).
Fewer overlaps may occur due to slower processing of incoming and outgoing speech.

We found an increase in the percentage number of Predictions for both speakers (difference between first and second recording: speaker 1 = 10.71% and speaker 2 = 33.33%). This outcome may indicate that the ability to follow the conversation is still preserved and that overlapping current speech is used in order to stay in the conversation (Ripich et al., 1991). In particular, the category Predictions seemed to be favoured by the patients for doing so.

For the categories Confirmation, FTT, FaiTT and FaiTTC, we did not find an increase or decrease for the number of Overlaps for both speakers; either one increased and the other one decreased in their overlap numbers or vice versa.
If the sample size were to be increased, observed trends could be more readily confirmed or disregarded.

Chapter 9 Results of the Comparison of Healthy and Patient/AD Data

Based on our previous findings, we will compare healthy and patient/AD data in the following section, as we were interested in the difference of conversational behaviour regarding overlaps and the suitability of the categories to characterise the different speaker groups.
Through using the pooled patient data, we were able to strengthen the statistical power of our comparisons.
We further present the differences between the healthy and AD subjects in regard to descriptive statistics (mean, StDev, median and CL effect size). The analysis is based on Familiarity comparing F H NL and F NL P/AD speakers as well as UnF H NL and UnF NL P/AD speakers. We also considered a comparison of each category.

8.1 Comparison of Healthy and Patient/AD Data

We were interested in whether the chosen categories (Confirmations, Predictions, FTT, FaiTT, FaiTTC and Others) were able to measure the difference in healthy and AD speech or not. For this matter, we compared NL patient/AD and NL healthy data as the following analysis will show.

<u>Numbers of Participants</u>
For the F condition, we had data from 12 healthy subjects and 12 patients (AD = 9, FTD = 3). For the UnF condition, we had data for 12 healthy subjects and nine patients (AD = 6, FTD = 3).

<u>Choice of Analysis</u>
We computed with the percentages derived from the number of Overlaps for each conversation and each NL speaker. The single results for the speakers are presented in Chapter 7 and 8. For the statistically more powerful comparison of the UnF NL H and the UnF NL P percentages, which we will report in the following sections, we first checked for normality by applying the Shapiro-Wilk test and continued with either a Two Sample t-test (normal distribution of data) or a Mann-Whitney U test (not normal distribution of data). We continued by evaluating the CL by either applying equation [1] or [2].

We computed the CL for AD subjects, too. In general, we were able to use the same equation as for the patient data. For one case, the number of Overlaps/total number of Overlaps% in the UnF condition, we found normally distributed data for both, F NL H and F NL AD percentages and continued by applying equation [1].

Number of Words/Conv

Words/Conv	F NL	F NL	UnF NL	UnF NL
Difference in	Means	Medians	Means	Medians
H NL / P NL	104.58	37	31.31	72.5
H NL / AD NL	102.92	30.5	35.75	50.5

Table 90 Difference in the number of Words/Conv

Words/Conv%	F NL	F NL	UnF NL	UnF NL
Difference in	Means%	Medians%	Means%	Medians%
H NL / P NL	0.43	1.81	7.72	5.39
H NL / AD NL	1.68	2.08	8.31	6.4

Table 91 Difference in the number of Words/Conv as %

Comparison of F data and percentages

As for the healthy and patient/AD study, we were interested in the difference between the number of Words/Conv. Therefore, we compared statistically the healthy and patient data (Table 90). Testing normality of the data, a Shapiro-Wilk normality test showed that the F NL H were not normally distributed, with F NL H: W = 0.81, p = 0.01. However the F NL P data were, with W = 0.94, p = 0.47. We applied a Mann-Whitney U test which did not show a significant difference in the ranks (U = 57.5, p = 0.4). We continued by computing the CL effect size by equation [2]; Z = 0.4 and CL = 0.6. The probability that a randomly selected F NL H subject will produce more Words/Conv than a randomly selected F NL P subject is 60%, a small sized effect.
We also computed CL for the F NL AD and the F NL H data and got Z = 0.39 (U = 42, p = 0.42). Therefore, the probability that a randomly chosen F NL H subject produces a higher number of Words/Conv than a randomly selected F NL AD speaker is 61%, implying a small sized effect.

Further, we wanted to know if the number of Words/Conv% (Table 91) was significantly different. The F NL P percentages were not normally distributed (F NL P: W = 0.77, p = 0.004). However, the F NL H percentages were (W = 0.97, p = 0-94). A Mann-Whitney U test revealed that the sum of ranks were not significantly different, with U = 59, p = 0.48.
Using equation [2], we computed Z = 0.41 and CL = 0.59: the probability that a randomly selected F NL H participant produced a higher number of Words/Conv than a randomly selected F NL P speaker is 59%; a small sized effect.
We also computed the Z and CL for the AD percentages. The result of equation [2] (U = 58, p = 0.81) revealed Z = 0.46 (CL = 0.54). The mean ranks showed a higher sum for the F NL H speakers

than for the F NL AD subjects. Therefore, the probability that a randomly selected F NL H speaker produces more Words/Conv% than a randomly selected F NL AD speaker is 54%. We did not find an effect.

Comparison of UnF data and percentages

We were interested in a statistical difference between the UnF NL H and the UnF NL P data for the number of Words/Conv and checked first for normality by applying a Shapiro-Wilk normality test. Both data sets were normally distributed (UnF NL H: $W = 0.95$, $p = 0.66$ and UnF NL P: $W = 0.94$, $p = 0.58$). We continued with a Two Sample t-test. The difference in the means for the number of Words/Conv was not significant, with $t(19) = 0.87$, $p = 0.4$.

To calculate the CL, we used equation [1] and got $Z = 0.26$ implying $CL = 0.6$. The probability that a randomly selected UnF NL H speaker produced a higher number of Words/Conv than a randomly selected UnF NL P speaker is 60% (small effect).

A further calculation (equation [1]) revealed $CL = 0.63$ ($Z = 0.32$) for the UnF NL AD and the UnF NL H data: the probability that a randomly selected UnF NL H subjects speaks more Words/Conv than a randomly selected UnF NL AD speaker is 63%, a small sized effect.

As for the F NL subjects, we wanted to check for significance in the percentage data, between UnF NL H and UnF NL P. The means% and medians% were higher for the UnF NL P (mean = 36.19%, median = 34.78%) and the UnF NL AD (mean = 36.78%, median = 35.79%) than for the UnF NL H (mean = 28.47%, median = 29.39%) subjects.

Shapiro-Wilk normality tests showed that the numbers of Words/Conv% were normally distributed for UnF NL H ($W = 0.92$, $p = 0.27$) and for UnF NL P ($W = 0.98$, $p = 0.95$) speakers. A Two Sample t-test failed to show significance for the mean percentages ($t(19) = -1.41$, $p = 0.18$).

We computed the CL in order to check the tendency that one group's percentages favour the other group. By applying equation [1], we calculated $Z = 0.41$ and $CL = 0.66$, which means that the probability that a randomly selected UnF NL P subject produced more Words/Conv% than a randomly selected UnF NL H speaker is 66%. We found a medium sized effect.

The AD and UnF NL H percentages revealed $CL = 0.64$ and $Z = 0.37$ by using the same equation. The probability that a randomly selected UnF NL AD speakers showed an increased number of Words/Conv% than a randomly selected UnF NL H speaker is 64%, a medium sized effect.

Number of Overlaps

For this parameter we were looking at

1. the number of Overlaps/total number of Overlaps% and
2. the number of Overlaps/Conv%.

Overlaps/total number of Overlaps%	F NL	F NL	UnF NL	UnF NL
Difference in	Means%	Medians%	Means%	Medians%
H NL / P NL	4.78	2.4	2.94	0.38
H NL / AD NL	3.82	0.71	4.79	0.59

Table 92 Difference in the number of Overlaps/total number of Overlaps as %

Overlaps/Conv%	F NL	F NL	UnF NL	UnF NL
Difference in	Means%	Medians%	Means%	Medians%
H NL / P NL	0.49	0.76	0.92	0.88
H NL / AD NL	0.45	0.75	1.11	1.14

Table 93 Difference in the number of Overlaps/Conv as %

Comparison of F percentages

Comparing the number of Overlaps/total number of Overlaps% (Table 92), we have conducted Shapiro-Wilk normality tests to see whether the percentages of the F NL H and the F NL P data were significantly different. The percentages were normally distributed for the F NL H data (W = 0.9, p = 0.18), but were not for the F NL P data (W = 0.69, p = 0.001). Therefore, we continued by applying the Mann-Whitney U test. The U test did not show a significant difference in the sum of ranks, with U = 55, p = 0.32.

Again, we have computed the CL effect size by using equation [2]: Z = 0.38, CL = 0.62. The probability that a randomly chosen F NL P speaker produced more Overlaps/total number of Overlaps% than a randomly selected F NL H subject is 62%; a small sized effect.

By using equation [2] for the AD percentages as well, we have calculated CL = 0.57 (Z = 0.43), with U = 46, p = 0.57. The probability that a randomly selected F NL AD subject produced a higher number of Overlaps/total number of Overlaps% than a randomly selected F NL H speaker is 57%. The effect can be considered as small.

For the number of Overlaps/Conv%, we compared statistically the percentage of the F NL H and the F NL P subjects (Table 93).

Whether the percentages of the F NL H and the F NL P data were significantly different or not was detected by a Mann-Whitney U test after the F NL H percentages revealed not normally distributed data (F NL H: W = 0.86, p = 0.04, F NL P: W = 0.93, p = 0.38). The U test result showed no significant difference in the sum of ranks: U = 48, p = 0.18.

The CL was computed with equation [2] and gave Z = 0.33, CL = 0.67. The probability that a randomly selected F NL P speaker produced a higher number of Overlaps/Conv% than a randomly selected F NL H speaker is 67%; a medium sized effect.
We were interested in the CL of the F NL AD and the F NL H interlocutors as well. By applying the same equation (U = 41, p = 0.38), we found Z = 0.38 and CL = 0.62, the probability that a randomly chosen F NL AD subject produced a higher percent number of Overlaps/Conv than a F NL H speaker is 62%, indicating a medium sized effect.

<u>Comparison of UnF percentages</u>
The number of Overlaps/total number of Overlaps% was higher for the UnF NL H speakers, than for the UnF NL P speakers. The median% for the UnF NL P speakers was higher than for the UnF NL H subjects (Table 9 and 41). Both, means% and medians% were lower for the UnF NL AD subjects compared to the UnF NL H subjects (Table 9 and 42).
We were interested whether the difference between the UnF NL H and the UnF NL P percentages were significantly different. We first checked for normality with Shapiro-Wilk normality tests: whilst the UnF NL H percentages were normally distributed (W = 0.92, p = 0.3), the UnF NL P percentages were not, with W = 0.77, p = 0.01. We continued by applying the Mann-Whitney U test. The U test did not show a significant difference in the sum of ranks (U = 54, p = 1).
We computed CL = 0.5 (Z = 0.5, n = 108) by using equation [2]. The probability that a randomly selected UnF NL P speaker showed a higher percentage of Overlaps/total number of Overlaps than a randomly selected UnF NL H speaker is 50%. No effect was found.
We mentioned earlier, that after we checked for normality for the UnF NL AD and UnF NL H percentages, we were able to find normally distributed data, with UnF NL AD: W = 0.82, p = 0.1 and UnF NL H: W = 0.92, p = 0.3 (t(16) = 0.5, p = 0.63). For computing CL for the two groups, we applied equation [1] with Z = 0.17 and CL = 0.57. The probability that a randomly selected UnF NL H speaker produced more Overlaps/total number of Overlaps% than a randomly selected UnF NL AD speaker is 57%. We found a small effect.

As for the F NL results, we also looked for a statistically significant difference for the number of Overlaps/Conv% and the descriptive statistics, including the UnF NL AD percentages. Therefore, we looked at the difference in the means% of UnF NL H and UnF NL P data (Table 93).
Shapiro-Wilk normality tests showed that both groups, UnF NL H and UnF NL P had normally distributed data%, with UnF NL H: W = 0.92, p = 0.26 and UnF NL P = 0.97, p = 0.93. We conducted a Two Sample t-test revealed a significant difference in the means%: t(19) = -1.96, p = 0.06 (alpha level = 0.1).
We further wanted to know about the CL for the percentages. By applying equation [1], we have calculated Z = 0.58 and CL = 0.72: the probability that a randomly selected UnF NL P speaker

produced a higher number of Overlaps/Conv% than an UnF NL H speaker is 72%. We found a large sized effect for the number of Overlaps/Conv%.

By using the same equation for evaluating the AD percentages compared to the UnF NL H data, we have computed a medium sized CL = 0.69 with Z = 0.5. The probability that a randomly chosen UnF NL AD speaker produced more Overlaps/Conv% than an UnF NL H speaker is 69%. We found a medium effect.

Number of Confirmations

Confirmations%	F NL	F NL	UnF NL	UnF NL
Difference in	Means%	Medians%	Means%	Medians%
H NL / P NL	5.13	15.44	2.1	2.86
H NL / AD NL	6.86	14.87	3.21	4.91

Table 94 Difference in the number of Confirmations as %

Comparison of F percentages

The F NL H percentages showed a mean percentage of 39.36% and a median percentage of 45.64%. The percent data of the F NL P subjects revealed a fewer mean% with 34.23%. The percentages of the F NL AD subjects showed the lowest mean with 32.5% (Table 15, 50 and 51). For comparing the percentages of the F NL H and the F NL P interlocutors, we conducted a Two Sample t-test, after the data sets showed a normal distribution (F NL H: W = 0.93, p = 0.44 and F NL P: W = 0.91, p = 0.24). The results did not show a significant difference in the mean percentages: t(22) = 0.63, p = 0.54.

Further, we have computed the CL for the F NL H and the F NL P data by using equation [1]. We calculated Z = 0.18 (CL = 0.57). The probability that a randomly selected F NL H speaker confirmed more often than a randomly selected F NL P speaker is 57%; a small sized effect.

A CL including the percentages of the F NL AD and the F NL H subjects was computed by using the same equation. As a result, we got Z = 0.26 and CL = 0.6, which mean that the probability that a randomly selected F NL H speaker produced a higher number of Confirmations% than a randomly selected F NL AD subject is 60%. We found a small sized effect.

Comparison of UnF percentages

We were interested whether the difference in the means% of the UnF NL H and the UnF L P data was significant or not (Table 94). Therefore, we conducted Shapiro-Wilk tests to estimate normality which was given for both, UnF NL H: W = 0.95, p = 0.7 and UnF NL P: W = 0.95, p = 0.67

groups. A Two-Sample t test revealed that the difference in the mean percentages was not significant, with $t(19) = -0.19$, $p = 0.85$.

The CL for the UnF NL H and the UnF NL P subjects was computed with equation [1]: Z = 0.06, CL = 0.52. The probability that a randomly selected UnF NL P speaker produced more Confirmations% than a randomly selected UnF NL H subject is 52%, implying no effect for the category Confirmations%.

We further computed CL the UnF NL AD and the UnF NL H percentages by using equation [1] as well. The results showed Z = 0.08 and CL = 0.53. The probability that a randomly selected UnF NL AD speaker used a higher number of Confirmations% than a randomly selected UnF NL H speaker is 53%. We could not find an effect.

Number of Predictions

Predictions%	F NL	F NL	UnF NL	UnF NL
Difference in	Means%	Medians%	Means%	Medians%
H NL / P NL	5.03	4.75	2.5	1.55
H NL / AD NL	4.43	8.45	0.17	2.65

Table 95 Difference in the number of Predictions as %

Comparison of F percentages

The mean% of the F NL P subjects was higher than for the F NL H speakers. The difference in the means for the F NL H and the F NL AD subjects was lesser (Table 95).

Testing the F NL H and the F NL P percent data was conducted by applying a Two Sample t-test. Both, F NL H ($W = 0.96$, $p = 0.82$) and F NL P ($W = 0.92$, $p = 0.29$) percentages were normally distributed. The t-test did not reveal a significant difference in the mean percentages, with $t(22) = -0.9$, $p = 0.38$.

The CL for these groups was calculated by applying equation [1]. We computed Z = 0.26 and CL = 0.6. The probability that a randomly selected F NL P subjects produced more percent Predictions than a randomly selected F NL H speaker is 60%, a small sized effect.

By considering the AD percentages, we computed CL = 0.6 (Z = 0.25) for the F NL AD and the F NL H percentages by using the same equation. The probability that a randomly selected F NL AD interlocutor initiated more Prediction overlaps% than a randomly selected F NL H speaker is 60%, a small sized effect as well.

Comparison of UnF percentages

The median% was higher for the UnF NL P subjects with 28.57% compared to the median percentage of the UnF NL H speakers (27.02%) (Table 17 and 55).

By considering the UnF NL AD speakers, we found a difference in the median percentages between UnF NL AD und UnF NL H data of 2.65%, whereby the median percentage was higher for the UnF NL AD subjects. In contrast, the mean percentage was slightly higher for the UnF NL H speaker than for the UnF NL AD subjects (Table 17 and 56).

However, to see whether the difference in the percentages between the UnF NL H and the UnF NL P groups was significant or not, we first checked for normality by applying a Shapiro-Wilk normality test. Both, UnF NL H (W = 0.95, p = 0.69) and UnF NL AD (W = 0.93, p = 0.53) percentages were normally distributed. A Two-Sample t-test did not show a significant difference in the mean percentages: t(19) = 0.34, p = 0.74.

CL for the UnF NL H and the UnF NL P data was computed by using equation [1]. The calculated Z = 0.1, with CL = 0.54. The probability that a randomly selected UnF NL H speaker produced a higher number of Predictions% than a randomly selected UnF NL P speaker is 54%. We found no effect.

We also computed CL for the UnF NL AD and the UnF NL H speakers: we used the same equation to find the Z = 0.01 (CL = 0.5). This means that the probability that a randomly selected UnF NL H speaker initiated more overlaps of the category Predictions% is 50%, implying no effect.

Number of FTT

FTT%	F NL	F NL	UnF NL	UnF NL
Difference in	Means%	Medians%	Means%	Medians%
H NL / P NL	0.96	5.42	4.63	2.59
H NL / AD NL	0.24	4.58	9.49	1.58

Table 96 Difference in the number of FTT as %

Comparison of F percentages

The F NL H speakers produced lesser FTT% than the F NL P speakers did (F NL H: mean% = 58.5% and F NL P: mean% = 59.46).

As we were interested in the significance of the difference in the percentages of the F NL H and the F NL P data (Table 96), we applied a Whitney-Mann U test. We had to decline normality for the F NL H percentages (W = 0.84, p = 0.03), but could confirm a normal distribution for the F NL P percentages (W = 0.96, p = 0.81). The U test did not show a significant difference in the sum of ranks, with U = 63, p = 0.6.

By applying equation [2], we computed a small CL = 0.56 for the F NL H and the F NL P percentages. We found Z = 0.44. The probability that a randomly selected F NL P speaker initiated more FTT% than a randomly selected F NL H speaker is 56%.

We used equation [2] again and computed CL = 0.6 for the F NL AD and the F NL H percentages as well (U = 47, p = 0.62). As a result, we got a Z = 0.43, which means that the probability that a randomly selected F NL AD speaker produced a higher percentage of FTT than a randomly selected F NL H subject is 57%, which is considered to be a small sized effect.

Comparison of UnF percentages

Whilst the mean% was lower for the UnF NL P speakers than for the UnF NL H subjects, the median percentage was higher for the UnF NL P participants than for the UnF NL H speakers (Table 20, 60 and 61).

We tested statistically if the difference between the UnF NL H and the UnF NL P percentages was significant or not by applying a Two Sample t-test after we could verify that the data sets were normally distributed (UnF NL H: W = 0.97, p = 0.96 and UnF NL P: W = 0.85, p = 0.07). The results showed that the difference in the mean percentages did not show significance (t(19) = -0.45, p = 0.66). Again, we calculated CL for both groups. We applied equation [1] and got Z = 0.14, implying CL = 0.56. The probability that a randomly selected UnF NL H speaker showed a higher occurrence of FTT% than a randomly selected UnF NL P speaker is 56%. A small effect was found.

We computed CL for the UnF NL AD and the UnF NL H subjects as well. Again, we used equation [1] to evaluate Z = 0.25 (CL = 0.6). The probability that a randomly chosen UnF NL H speaker initiated a higher percentage of FTT than a randomly selected UnF NL AD speaker is 60%. Again, a small effect was found.

Number of FaiTT

FaiTT%	F NL	F NL	UnF NL	UnF NL
Difference in	Means%	Medians%	Means%	Medians%
H NL / P NL	0.96	5.42	6.48	5.92
H NL / AD NL	0.24	4.59	7.18	12.7

Table 97 Difference in the number of FaiTT as %

Comparison of F percentages

As we were interested in a statistical difference between the F NL H and the F NL P percent data (Table 97), we checked for normality by using a Shapiro-Wilk normality test in order to conduct either a Two-Sample t-test or a Mann-Whitney U test. The F NL H data did not show a normal distribution of data (W = 0.84, p = 0.03) whilst the F NL P data (W = 0.96, p = 0.81) showed normally distributed percentages. A Mann-Whitney U test did not show a significance in the sum of ranks, with U = 63, p = 0.6.

We continued with the calculation of the CL for the F NL H and the F NL P percentages by using equation [2]. As a result, we got a Z = 0.44 and CL = 0.56. The probability that a randomly selected F NL H speaker produced a higher percentage of FaiTT than a randomly selected F NL P speaker was 56%, which is considered as a small effect.

The CL was computed for the F NL AD and the F NL H subjects, too. We also used equation [2] and as a result, we computed Z = 0.44 and CL = 0.56, which means that the probability that a randomly chosen F NL H speaker showed a higher occurrence of FaiTT% than a randomly selected F NL AD subject is 56%. We could find a small sized effect.

Comparison of UnF percentages

We conducted Shapiro-Wilk normality tests for checking whether the difference in the percentages of the UnF NL H and the UnF NL P data are normally distributed (Table 97). As a result, both data sets were normally distributed, with UnF NL H: W = 0.97, p = 0.96 and UnF NL P: W = 0.96, p = 0.8. A Two Sample t-test showed that the difference in the mean percentages was not significant (t(19) = 0.73, p = 0.47).

An Z was computed by applying equation [1]. We found Z = 0.23 and CL = 0.59. The probability that a randomly selected UnF NL H speaker showed a higher percentage of FaiTT than a randomly selected UnF NL P speaker is 59% which is considered as a small effect.

The UnF NL AD and the UnF NL H subjects showed CL = 0.59 (Z = 0.22). We calculated with equation [1] as well. The probability that a randomly selected UnF NL H subject produced a higher number of FaiTT% than a randomly chosen UnF NL AD subject is 59%. We could find a small effect.

Number of FaiTTC

FaiTTC%	F NL	F NL	UnF NL	UnF NL
Difference in	Means%	Medians%	Means%	Medians%
H NL / P NL	4.59	2.43	0.66	3.27
H NL / AD NL	4.59	0.32	2.77	1.22

Table 98 Difference in the number of FaiTTC as %

Comparison of F percentages

We were interested if the difference between the F NL H and the F NL P percentages was significantly different (Table 98). As the Shapiro-Wilk normality tests showed a non-normal distribution for the F NL H percentages ($W = 0.85$, $p = 0.04$), but for the F NL P percentages ($W = 0.95$, $p = 0.62$), we conducted a Mann-Whitney U test. The difference in the sum of ranks was not significant, with $U = 65$, $p = 0.69$.

For getting the CL, we applied equation [2] on to the F NL H and the F NL P percentages with $Z = 0.45$ and $CL = 0.55$. The probability that a randomly selected F NL H speaker produced a higher percentage of FaiTTC than a randomly selected F NL P speaker is 55%. No effect was found.

We were also interested in the CL for the F NL AD and the F NL H subjects. By applying equation [2] ($U = 48$, $p = 0.67$), we got $Z = 0.44$ and $CL = 0.56$, which means that the probability that a randomly selected F NL H speaker produced a higher percentage of FaiTTC than a randomly selected F NL AD subject is 56%; a small sized effect.

Comparison of UnF percentages

We wanted to check if the difference between the UnF NL H and the UnF NL P percentages was significant or not (Table 98). We therefore applied a Two Sample t-test, after we had to confirm normality for the UnF NL H speakers ($W = 0.89$, $p = 0.08$). The UnF NL P percentages were normally distributed, with $W = 0.95$, $p = 0.67$. The Two Sample t-test revealed that the difference in the mean percentages was not significant ($t(19) = 0.01$, $p = 0.99$).

A computed $CL = 0.5$ (equation [1]) and $Z = 0.002$. The probability that a randomly selected UnF NL H speaker produced a higher percentage of FaiTTC overleaps than a randomly selected UnF NL P speaker is 50%, which is considered as no effect.

We also calculated $CL = 0.54$ ($Z = 0.11$) for the UnF NL AD and the UnF NL H speakers (equation [1]). The probability that a randomly selected UnF NL H speaker showed a higher percentage of FaiTTC than a randomly selected UnF NL AD speaker is 54%. No effect was found.

Number of Others

Others%	F NL	F NL	UnF NL	UnF NL
Difference in	Means%	Medians%	Means%	Medians%
H NL / P NL	2.17	3.34	13.2	5.36
H NL / AD NL	0.04	2.59	16.86	8.93

Table 99 Difference in the number of Others as %

Comparison of F percentages

The F NL H speakers had a higher mean percentage than the F NL P subjects and AD subjects. The median percentages showed higher percentages for the F NL P and F NL AD speakers (Table 29, 73 and 74).

As the Shapiro-Wilk normality tests failed to show normal distribution of the F NL H percentages ($W = 0.82$, $p = 0.01$) and the NL P percentages: $W = 0.86$, $p = 0.049$), we continued with the Mann-Whitney U test. The U test did not show significance in the sum of ranks, with $U = 72$, $p = 1$.

We computed $CL = 0.5$ and $Z = 0.5$ for the F NL H and the F NL P data by using equation [2.] The probability that a randomly selected F NL P subject initiated more overlaps of the category Others than a randomly selected F NL H speaker is 50%; no sized effect.

By considering the F NL H and the F NL AD subjects, we found $CL = 0.52$ ($Z = 0.48$) by using the same equation ($U = 52$, $p = 0.89$). The probability that a randomly chosen F NL AD speaker showed a higher percentage of overlaps of the category Others than a randomly selected F NL H subject is 52%%. We could not find an effect.

Comparison of UnF percentages

The median and mean percentages were higher for the UnF NL H subjects than for both, the UnF NL P and UnF NL AD speakers (Table 29, 73 and 75).

We wanted to see whether the difference between the UnF NL H and the UnF NL P percentages was significant or not (Table 99). Therefore, we first checked the data for normality by applying Shapiro-Wilk normality test. The results failed to show normality for the UnF NL H speakers ($W = 0.8$, $p = 0.01$), but revealed a normal distribution of the UnF NL P percentages ($W = 0.84$, $p = 0.06$). Based on this outcome, we conducted a Mann-Whitney U test. We found no significant difference for the sum of ranks ($U = 36$, $p = 0.19$).

The $Z = 0.33$ and $CL = 0.67$ for the UnF NL H and the UnF NL P percentages was calculated by applying equation [2]. The probability that a randomly selected UnF NL H subject initiated a higher percentage of Others than a randomly selected UnF NL P subject is 67%, implying a medium effect.

We used the same equation for the UnF NL AD and the UnF NL H subjects ($U = 20$, $p = 0.12$) and got $Z = 0.28$ and $CL = 0.72$. The probability that a randomly selected UnF NL H subjects produced a higher number of Others% than a randomly selected UnF NL AD subject is 72%; a large sized effect.

Comparison of NL H, NL P and NL AD percentages

As we were interested in the difference of healthy and patient/AD speech, we further combined the F NL and UnF NL data of each group (H, P and AD) and compared the dementia groups with the healthy one. As an example of the combined data, we present the mean and mean as percentages for all variables in Table 100.

We evaluated the significance of the difference for the number of Words/Conv of the NL H and NL P data by using a Mann-Whitney U test as only the NL P data were normally distributed, with W = 0.96, p 0.58 (H NL: W = 0.74, p = 0.001 and NL P: W = 0.96, p = 0.58). The difference in the sum of ranks was not significant, with U = 195, p = 0.19. We computed CL = 0.61 (Z = 0.39) by using equation [2]. We found a small sized effect for a higher probability that an NL H speaker spoke more Words/Conv than a randomly selected NL P subject.

We also looked for an effect size in healthy and AD speech for the number of Words/Conv and computed Z = 0.39 (CL = 0.61) by using equation [2] (U = 139.5, n = 360). The ranks told us that a randomly selected NL H speaker has a probability of 61% to produce more Words/Conv than a randomly selected NL AD speaker.

Further, we were interested if the percentage of the number of Words/Conv differed significantly for the NL P and NL H groups. Shapiro-Wilk normality tests revealed that the NL P percentages were not normally distributed (NL P: W = 0.89, p = 0.03 and NL H: W = 0.98, p = 0.83). We continued by applying a Mann-Whitney U test, but did not show a significant difference in the ranks (U = 251, p = 0.99). No effect was found, with CL = 0.5 (Z = 0.5) (equation [2]). We proceeded to calculate CL for NL H and NL AD speech. However, as we found normal distributed data for both groups, we applied equation [1] on to percentages. As a result we got Z = 0.12 and CL = 0.55, implying no effect.

Whether the difference between the number of Overlaps/total number of Overlaps% was significant or not was tested by using a Mann-Whitney U test (NL P: W = 0.81, p = 0.001 and NL H: W = 0.97, p = 0.75). The test did not show a significant difference in the sum of the ranks (U = 234, p = 0.68). By applying equation [2], we found CL = 0.54 (Z = 0.46) which is considered as no effect. For the AD and healthy speech percentages, we found no effect either (U = 173.5, CL = 0.52 and Z = 0.48).

The difference regarding statistical significance between the number of Overlaps/Conv was computed by using a Two Sample t-test as both groups, NL H and NL P data% were normally distributed (NL P: W = 0.98, p = 0.85 and NL H: W = 0.98, p = 0.97). We found a significant difference in the mean percentages, with t(43) = -2.59, p = 0.01. A CL was calculated by using equation [1]. The probability that a randomly selected NL P speaker produced a higher number of Overlaps/Conv% than a randomly selected NL H subject is 71%; implying a large effect (CL = 0.71 and Z = 0.54).

The CL for AD and healthy speech was computed by using equation [1] as well. We found a medium sized effect, with CL = 0.64 (Z = 0.35), favouring the NL AD speakers over the NL H speakers.

	NL H	NL P	NL AD
Words/Conv	229	162.29	162
Words/Conv%	27.93	30.92	32.15
Overlaps/total number of Overlaps%	48.54	50.41	49.48
Overlaps/Conv%	1.74	2.42	2.15
Confirmations%	41.35	39.04	38.12
Predictions%	27.58	29.18	29.9
FTT%	60.39	58.68	56.07
FaiTT%	39.61	36.56	37.26
FaiTTC%	23.04	20.92	19.92
Others%	19.39	12.18	12.19

Table 100 Mean and mean percentages for NL H, NL P and NL AD (only) data

Distribution of categorical percentages of the number of Overlaps for NL H, NL P and NL AD data

Table 101 and 102 show the differences between the overall percentages per category for healthy and patient and for the healthy and AD speech.

We were interested in whether the differences between the NL H and NL P were significant or not.

The difference between the percentages for the category Confirmations was high with a difference of 2.31%, but even higher for the median percentages.

For the category Confirmations, we found normally distributed data (NL H: W = 0.96, P = 0.54 and NL P: W = 0.93, p = 0.17). We continued by applying a Two Sample t-test which did not show a significant difference in the means% (t(43) = 0.35, p = 0.73). An effect was not found (CL = 0.53, Z = 0.07 by using equation [1]). Further, we calculated CL for healthy and AD speech regarding the category Confirmations applying the same equation. No effect was found, with Z = 0.1 and CL = 0.54.

The difference between the percentages in the category Predictions was not significant either following a Two Sample t-test (t(43 = -0.36, p = 0.72)). No effect was found (CL = 0.53 and Z = 0.07, equation [1]). We got the same result for the NL H and NL AD data: CL = 0.55 and Z = 0.12, applying equation [1].

The FTT% data were not normally distributed for NL P (W = 0.9, p = 0.03), but were for the NL H percentages (W = 0.95,p = 0.32). A Mann-Whitney U test did not reveal a significant difference in the sum of ranks (U = 242, p = 0.82). As CL = 0.52 (Z = 0.48), no effect was found. For the NL H and

NL AD speech data, the highest difference in the mean percentage was detected within the FTT% category. We found a small effect for the NL H and NL AD data%, with Z = 0.16 and CL = 0.56. The probability that a randomly selected NL H speaker initiated more FTT% overlaps than a NL AD speaker is 56%.

The highest difference in the means% between the H NL and P NL was found in the category FaiTT%. We computed a CL = 0.55 (Z = 0.13) by using equation [1], favouring the H NL group over the P NL percentages, but no effect was found. As the percentages for both groups were normally distributed (NL H: W = 0.95, p = 0.32 and NL P: W = 0.99, p = 0.1), we conducted a Two Sample t-test, but did not find a significant difference in the means%, with t(43) = 0.6, p = 0.55.
For the NL H and NL AD percentages, we found a CL = 0.19 and Z = 0.53, implying no effect.

We computed a Two Sample t-test for the category FaiTTC% as both, NL H and NL P percentage data were normally distributed (NL H: W = 0.93, p = 0.12 and NL P: W = 0.95, p = 0.39). The outcome did not show significant difference for the means% (t(43) = 0.46, p 0.65). The CL = 0.54 (Z = 0.1) showed no effect for the data. However, the difference between NL H and NL AD data% showed CL = 0.56 (Z = 0.14) revealing a probability of 56% that a randomly selected NL H speaker shows a higher number of FaiTTC% overlaps than a NL AD subject. We found a small effect.

The only small effect we computed by using equation [2] were found for the percentages of the category Others for the NL H and NL P data, with CL = 0.58 (Z = 0.42) were the probability that a randomly selected NL H speaker produced a higher number of Others% than an NL P speaker is 58%. A Mann-Whitney U test did not show a significant difference in the sum of ranks, with U = 213, p = 0.36, following the results of a Shapiro-Wilk normality test revealing not normally distributed data for NL H: W = 0.8, p = 0.001 and NL P: W = 0.83, p = 0.001.
We calculated a small effect size for the difference between the Others percentages for the NL H and NL AD speakers (equation [2]: U = 149, p = 0.36). The probability that a randomly selected NL AD speaker initiated a higher percentage of Others overlaps than a randomly selected NL H speaker is 59% (Z = 0.41, CL = 0.59).

Difference NL H and NL P	Confirmations%	Predictions%	FTT%	FaiTT%	FaiTTC%	Others%
Mean%	2.31	1.6	1.71	3.05	2.12	7.21
Median%	14.39	2.73	6.05	8.95	1.75	2.92

Table 101 Difference between the ratio of categories% of the number of Overlaps (healthy and patient study)

Difference NL H and NL AD	Confirmations%	Predictions%	FTT%	FaiTT%	FaiTTC%	Others%
Mean%	3.23	2.31	4.32	2.35	3.12	7.2
Median%	14.39	4.93	3.27	4.95	0.63	3.84

Table 102 Difference between the ratio of categories% of the number of Overlaps (healthy and AD study only)

9.2 Discussion

Regarding our research questions (see Chapter 4 and above) and our interest in the in the occurrence of overlaps, the findings for the categories and finally the question about a difference between healthy speech and speech in dementia, we will only look into the results of the AD and healthy subjects. As abovementioned, we will report the percentages of the descriptive statistics of the AD group rather than the numbers as we did not control the length of our recordings as well as the significant difference in the means% or medians% of the overall patient data if found.

Suitability of the chosen categories for characterising healthy and AD conversations and their measurability

In order to differentiate H and AD speech, we found a medium effect regarding the number of Overlaps/Conv% favouring the NL AD speakers over the NL H subjects. In our experiment, the NL AD speakers interrupted more often during a conversation.

This outcome was also found by Guinn and Habash (2012) who demonstrated in their study that a failure of concept is present leading into disfluency in AD speech in higher rates than in healthy speech. Our data also shows a higher rate of Overlaps/Conv% for AD speech, which we interpret as a limitation in planning and execution of speech.

Considering our categories as giving information about the ability of planning and executing an intended overlap with the aim of taking the floor, we found the greatest difference in the mean percentages and median percentages between NL H and NL AD speakers for the category

Confirmations. Based on the difference and the descriptive statistics of the NL H and NL AD subjects, we found higher percentages for the NL H speakers than for the NL AD speakers regarding Confirmations overlaps. As mentioned in Chapter 6, we did not assume a higher number for the NL H speakers as we thought that simple structured utterances such as Confirmations would be easy to recall for the AD patients and therefore be a preferred method for staying in the interaction. However, we could not find an effect in our data showing that, in fact, we may have to reconsider our statement.

In the category Predictions, we found no CL effect and also a smaller difference between the percentages showing that the ability to predict is still preserved in AD speech, considering our observations. Regarding the descriptive statistics, greater percentages were found for the NL AD speakers which goes in line with our expectation.

As we found a small CL effect size for the category FTT, characterising the strategic and intentional behaviour during the conversations, we were able to measure that NL AD subjects were less successful in taking the floor fully. The same observation was made for the category FaiTTC showing a small effect. The NL H speaker seemed to be able to Complete their initiated Turn-Taking more often than NL AD subjects. This outcome confirms our assumption, presented in Chapter 6. By considering the research of Dijkstra and Bourgeois (2004), who looked at interview style conversations and their discourse in 30 dementia and 30 healthy subjects and their partners, AD patients have difficulties in maintaining topics and cohesion. They found further, that AD speech is abortive. We suggest that due to maintaining and probably concentration difficulties of AD speakers, a full performance of a turn-taking may be limited and led to a decreased number of Full Turn-Takings initiated by an overlap for our AD subjects.

Regarding the category FaiTT, we found no effect; the difference between the data was small. However, the NL H group revealed greater percentages than the NL AD group, as we previously expected. We assumed that the L AD speakers would dominate the conversation and provide more space for the patient’s speech, avoiding an overrun or interruption.

Overlaps marked as Others demonstrated the greatest difference between NL AD and NL H speakers. Laughs or editing terms, but also not understandable words (due to poor articulation in AD speech) seemed to be measurable for each group.

Our expectations were confirmed for five of six categories if considered the percentage mean and four of six if the percentage medians are considered.

We assume that due to our small sample size (n (recordings) = 45: F NL AD = 9, F NL P: 12, F NL H = 12 and UnF NL AD = 6, UnF NL P = 9, UnF NL H = 12), we could only show a significant difference for the means% of the number of Overlaps/Conv% between NL H and NL P as well as between UnF NL H and UnF NL P results.

For the comparison of percentages and numbers, we analysed ten variables: number of Words/Conv, number of Words/Conv%, number of Overlaps/Conv%, number of Overlaps/total number of Overlaps%, number of Confirmations%, number of Predictions%, number of FTT%, number of FaiTT%, number of FaiTTC% and number of Others%. However, as we calculated with percentages rather than with numbers, we will only report the means% and medians%. An exception was made for the number of Words/Conv. This variable was evaluated by its numbers.

Comparison of the data for each condition

In the following, we will report our H/AD results of the comparison of the F NL subjects and the UnF NL speakers.

Words/Conv

The number of Words/Conv showed higher numbers for the F NL H subjects. The CL was small sized favouring the F NL H speakers over the F NL AD subjects. It seemed that the F NL H speakers were more involved in the overall conversation than the F NL AD speakers. This may have been attributable to a more dominant F L AD within the AD conversations or to a limited knowledge and processing of words of the F NL AD subjects. As we have mentioned earlier, AD patients suffer from difficulties in participating in spontaneous speech and our finding supports this assumption in the F condition (Guinn and Habash, 2012).

However, by looking at the mean and median percentages, the number of Words/Conv% showed that the F NL AD subjects were actually more involved in the conversations than F NL H subjects speaking with a familiar conversational partner. We did not find an effect though (CL = 0.54), supporting our finding that F NL H and F NL AD subjects did not differ significantly in their contribution to the conversations.

In the UnF condition, the UnF NL H speakers had a higher mean and median for the number of Words/Conv than the UnF NL AD subjects. The CL effect size was over 0.63 and indicated a stronger tendency towards a probability that UnF NL H speakers produced in general more Words/Conv. Again, it seemed that the UnF NL H speakers were more involved in the conversation. However, this outcome should be considered carefully as evidence since firstly, the number of UnF NL H speakers was higher (n = 12) than for the UnF NL AD subjects (n = 6) and secondly, because an increased use of Words/Conv may depend on personality (e.g. shy = fewer words).

The number of Words/Conv% was higher for the UnF NL AD than for the UnF NL H speakers and demonstrated that calculating with percentages rather than numbers gives a correct view of the data distribution in relation to different conversational length. A CL effect size of 0.64 showed that the UnF NL AD speakers were more involved in their conversations than UnF NL H subjects. This observation may be due to a certain conversational behaviour of the Lead speaker, who's goal may be a greater inclusion of the UnF NL AD interlocutor in the talk.

Overlaps/Conv

A similar observation was made for the percentage number of Overlaps/Conv% where the F NL AD speakers initiated more overlaps than the F NL H participants. A CL effect size of 0.62 indicated that the probability that an F NL AD subject overlapped more often than an F NL H interlocutor did, was small.

The percentage for the number of Overlaps/Conv differed in 0.88% (percentage mean) between the UnF NL AD and the UnF NL H speakers. The difference in the mean percentages was significant. The CL effect size was high with 0.69, showing a tendency towards a stronger probability that an UnF NL AD speaker produces a higher percentage of Overlaps/Conv.
We found higher occurrences of Overlaps/Conv% in the UnF NL AD recordings. We interpret overlaps here as a reference for having difficulties with planning and timing, being attributed to AD speech (Sabat, 1991).

Overlaps/total number of Overlaps%

By comparing the F NL H and the F NL AD results regarding the percentage of the number of Overlaps/total number of Overlaps, the F NL AD subjects overlapped more often than the F NL H subjects. Within a conversation with a familiar lead, it seemed that F NL AD subjects were more confident to initiate overlaps than they were with an UnF L. However, the difference between the median percentages was very low, with only 0.71%, whereas the difference between the mean percentages was 3.82%. However, the CL effect size was 0.61 and revealed a small probability than a randomly selected F NL AD overlapped more often than a randomly selected F NL H subject. As the difference between the median percentages is small, but the data revealed a small effect, we should treat the effect size carefully and consider that the F NL AD sample (n = 9) was smaller compared to the F NL H sample size (n = 12). The result may be distorted. The standard deviation was higher for the F NL AD subjects (17.36%) than for the F NL H subjects (11.09%), revealing that the small sample size had more widely distributed data (min = 50% and max = 100%) compared to the F NL H subjects (min = 35% and max = 78.47%). This finding supports the assumption of distortion regarding the CL effect size, but nonetheless, we found a slightly greater probability that the F NL AD subjects produced a higher percentage of Overlaps/total number of Overlaps than the F NL H subjects.
The UnF NL AD and the UnF NL H subjects revealed higher mean and median percentages for the UnF NL H subjects regarding the number of Overlaps/total number of Overlaps. The CL effect size

was 0.57, marginally, favouring the UnF NL H speakers over the UnF NL AD subjects. The UnF NL H subjects seemed to be less shy to interrupt their conversational partners than the UnF NL AD subjects.

Confirmations

The category Confirmations showed, with a CL effect size of 0.60, that the probability that a randomly selected F NL H subjects produced a higher percentage of Confirmations than a randomly chosen F NL AD speaker was present. F NL H speakers overlapped more often than F NL AD subjects. This overlapping behaviour might be relatable to the AD patients' inability to contribute easily to spontaneous speech and their limited concentration and attention systems (Orange et al., 1998). Due to our experiment design, the NL AD subjects took the speech task with a familiar person at first and were therefore unfamiliar with the task which may have led to a more reluctant behaviour in this category. We mentioned earlier that the AD patients tend to be confused about the instructions, but became familiar with the map task once their partners/carers started. The F NL H subjects, in contrast, had no difficulties understanding the task and the instructions. This ability has probably led to a higher percentage of Confirmations in comparison to the F NL AD percentages, as they were able to give feedback from the start onwards.

It may be argued that if the sample size of the F NL AD subjects were increased their use of Confirmation overlaps would increase, too. However, based on the arguments above and the CL effect of 0.60, we assume that the tendency that the F NL H subjects confirmed more often is convincing.

Our findings for the category Confirmations regarding the UnF NL AD and the UnF NL H speakers showed a higher occurrence for the UnF NL AD subjects, which was a contrary observation to the F NL percentages, see above. The CL effect size was 0.53, we could not find an effect in our data. We may argue that the behaviour of both groups was similar, as both were reluctant due to their unknown partner (see section 7.2 for the healthy study' interpretations). This may be interpreted, considering the results for the F NL AD subjects, that the AD patients' behaviour, as well as their conversational partners does change, depending on Familiarity (Sabat, 1991).

Again, the large difference between the sample sizes (UnF NL AD = 6, UnF NL H = 12) has probably affected the result. Based on the standard deviation (UnF NL AD = 33.49%, UnF NL H = 22.2%), we may say that the unbalanced sample size and the large difference between the data within the UnF NL AD group had an impact on the descriptive statistics. However, considering our data, at this point, we were not able to favour one group over the other.

Predictions

Higher percentages were observed for the F NL AD subjects with a small effect size of 0.60 in the category Predictions. The F NL AD subjects seemed to be more confident in overlapping the current speech by initiating Predictions than the F NL H subjects. This might be an indicator that the AD's speech and conversational behaviour is impaired regarding the ToM in terms of acknowledging the current (familiar) speaker's right to speak. A frequent overlapping behaviour of the category Predictions may reflect the difficulty for the AD patient in balancing the speech flow (Guinn and Habash, 2012; Watson, 1999). The more often a possible TRP is used for taking a turn, the higher is the probability of an interruption in the conversation and the speech flow. Another reason for our finding of higher percentages of the number of Predictions for the F NL AD speakers may be that with a familiar partner, these subjects were more demanding in terms of participating, whilst the F NL H participants relied on the usual equal participation in the conversation (Sabat, 1991).

The UnF NL AD and the UnF NL H subjects showed, for the category Predictions, a higher mean percentage, but a lower median percentage for the UnF NL H participants. We calculated a CL effect size of 0.50. Based on this outcome, for our data, there was no tendency towards a higher use of Predictions the UnF NL H subjects.
It may be assumed that the UnF NL H subjects are more confident to interrupt by initiating an overlap caused by predictability or that the UnF NL AD subjects may be limited in their ability to predict a possible or upcoming TRP as often as the UnF NL H speakers did (Taler and Phillips, 2008).
However, the UnF NL AD speaker showed a similar use of Predictions% and their ability to predict an upcoming or possible TRP seemed to be preserved.

FTT

A higher percentage for the F NL H subjects than for the F NL AD subjects in the category FTT was observed, but with a difference in the mean percentages of only 0.24%. By looking at the median percentages, we found a greater difference (4.58%) between the F NL H and the F NL AD subjects. However, for the median percentages, we counted a higher number of FTT% for the F NL AD rather than for the F NL H subjects. As the mean ranks showed a higher occurrence of FTT% for the F NL AD subjects, we concluded that a probability of 57% exists which favoured the F NL AD speakers over the F NL H speakers. We assume that the difference in the median percentages was due to stronger confidence by the F NL AD speakers that the F L AD partner will accept an initiated FTT than that of F NL H in a F L H partner who's aim was to complete the speech task as efficient (fast) as possible. The F NL H speakers were probably more hesitant towards their partners than

the F NL AD subjects and therefore decreased the percentage occurrence of FTT (Sabat, 1991; Sacks et al., 1974).
We had fewer F NL AD participants than F NL H subjects, therefore we support the difference in the median percentages as more representative than the mean percentages for the speech and conversational behaviour. The difference in the median percentages might be a good indicator for a tendency that the F NL AD subjects initiated an FTT overlap more often than the F NL H speakers. The tendency was supported by a small CL effect size as well.

The UnF NL AD and the UnF NL H speakers showed a higher percentage of FTT overlaps for the UnF NL H subjects than the UnF NL AD speakers. The computed CL effect size resulted in 0.60. The tendency towards the UnF NL H subjects as greater initiators of FTT overlaps, may show a greater need to influence the conversation and to take the floor more often (Taler and Phillips, 2008). The awareness of their own conversational difficulties may have stopped the AD speakers from initiating an overlap that would lead to a FTT overlap (Illes, 1989; Ripich et al., 1991).
However, the mean and standard deviation percentages showed a higher difference in the percentages and an increase of the number of subjects might demonstrate a significant difference in the data and increase the effect size.

FaiTT

In the category FaiTT, the F NL H subjects showed a higher percentage median than the F NL AD speakers. Considering the percentage means, the F NL AD speakers showed a higher percentage than the F NL H subjects. The CL effect size, where the sum of ranks favoured the F NL H speakers, was 0.57 and very mild. This outcome may be interpreted as a greater willingness to stop the initiated turn taking by the F NL H subject than by the F NL AD speaker in order to ensure that the speech flow is not interrupted if e.g. information needed is provided by the current speaker whilst the F NL H subject starts to overlap (Murdoch et al., 1987). It may also be that the conversational partners of the F NL AD speakers are more dominant in their speech and that they forced the F NL AD subject to stop their speech by overrunning the initiated FaiTT overlap (Sabat, 1991).
However, as the CL effect size is mild and the standard deviations are broadly distributed, we cannot say for certain that one group can be favoured over the other. An increased number of participants may demonstrate a stronger effect.

Regarding the results of the UnF NL AD and the UnF NL H participants in the category FaiTT, we observed that the UnF NL H subjects initiated more FaiTT% overlaps than the UnF NL AD subjects. We calculated a small CL effect size of 0.59 favouring a higher probability for the F NL H speakers as the sum of ranks suggested. This effect size is in agreement with the greater differences in the

percent data and an indicator that there may be a strong difference between the UnF NL H and the UnF NL AD subjects for the category FaiTT. The UnF L AD speakers may tend to ease the situation for the UnF NL AD speakers and overrun the interlocutor's speech in order to avoid a conversational break-down or to provide guidance.
We assume that if the number of participants were equal between groups, a clearer tendency towards one group might become obvious.

FaiTTC

For the category FaiTTC, we found a higher mean percentage for the F NL H subjects than for the F NL AD subjects and a higher median percentage for the F NL AD speakers than for the F NL H participants. As can be seen, the difference between the median percentages was small (0.32%). We computed a small CL effect size of 0.56 favouring the F NL H group. The tendency towards a higher probability that a F NL H speaker had a higher number of FaiTTC% than a F NL AD subject is very mild. We assume that the great standard deviation of both groups and the fact that there were three more recordings for the F NL H group may have influenced the result.
AD speech tends to be highly routinized and AD speakers are favouring using briefer utterances, keeping in mind that spontaneous speech gets difficult due to limited planning and executive abilities, these routines are still preserved and probably similar in occurrence of FaiTTC overlaps as for the healthy speakers (Ripich et al., 1991).

The mean and median percent number of FaiTTC is slightly higher for the UnF NL H subjects than for the UnF NL AD speakers. A tendency towards a higher number of FaiTTC in the UnF NL H group was not demonstrated by a measureable effect.
Based on the percentages it seemed that the UnF NL H speakers were more confident in finishing their turn, though they did not take the turn fully, than the UnF NL AD subjects. As the sample size for the UnF NL AD group (n = 6) was smaller than the sample size of the UnF NL H group (n = 12), this outcome may be biased by the UnF NL H data. However, we note that a tendency towards an increased number of FaiTTC by the UnF NL H speakers. This finding may also be an indicator that UnF NL AD subjects were more reluctant to finish their turns whilst they were overrun by their conversational partners.

Others

The category Others had, for the F NL AD and F NL H data, no measurable effect. The mean and percentages revealed a higher number for the F NL H subjects than for the F NL AD subjects. The median percentages showed a higher percentage for the F NL AD subjects. The difference in the mean percentages was 0.04% and in the median percentages 2.59%. There was not an indicator that overall, the F NL AD speakers were more willing to take a risk in terms of overlapping than the F NL H subjects.

The UnF NL percent data showed higher percentages for the UnF NL H speakers than for the UnF NL AD subjects. The CL effect size was large at 0.72. This outcome was exactly the opposite behaviour than that which was observed for the F NL H and the F NL AD speakers. However, by looking at the high StDev within the UnF NL H percent data, the result may have been influenced by the sample size. A higher number of recordings may have demonstrated a different behaviour. Considering the difference in the median percentages (8.93%), a tendency towards a higher number of Others for the UnF NL H speakers could be assumed. As the category Others was not tightly defined and included e.g. laughter, onset sounds and editing terms, we are not able to give an interpretation of the result other than that the finding indicated that UnF NL H speakers may use more features than we could find according to our categories.

Considering the descriptive statistics for each category, greater differences (> 5%) under the F condition was found for the categories Confirmations (mean = 6.86%, median = 14.87%) and Predictions (median = 8.45%).
Greater difference (> 5%) was found for the categories FTT (mean = 9.49%), FaiTT (mean = 7.18%, median = 12.7%) and Others (mean = 16.86%, median = 8.93%) between the UnF NL H and the UnF NL AD group.

Under the F condition, four out of six categories showed higher mean percentages for the F NL H speakers than for the F NL AD subjects (Confirmations, FTT, FaiTTC and Others). Considering the median percentages, only one out of six categories revealed higher percentages for the F NL H speakers (Confirmations).
The UnF NL H subjects dominated five of six categories with higher mean percentages by the (Predictions, FTT, FaiTT, FaiTTC and Others). The UnF NL H showed higher median percentages for the categories FTT, FaiTT, FaiTTC and Others.
We found a small effect for the F NL AD and the F NL H percentages for the categories Confirmations (0.6), Predictions (0.6), FTT (0.57), FaiTTC (0.56), number of Words/Conv (0.61), number of Overlaps/total number of Overlaps% (0.57) and for the number of Overlaps/Conv% (0.62).
In summary, we found effects for each category except for Others.

Small CL effect sizes for the UnF NL AD and the UnF NL H percentages were calculated for the categories FTT (0.6) and FaiTT (0.59) and for the number of Words/Conv (0.63). A medium effect

was found for number of Words/Conv (0.64). A large CL effect was calculated for the category Others (0.72).
We could not find an effect for the categories Confirmations, Predictions and FaiTTC for the UnF NL H and UnF NL AD percentages.

Though we could not show statistically significant results for the categories, we observed greater differences in the percentages for some and, mostly, moderate CL effect sizes.
We showed a moderate (> 0.64) CL effect size for the number of Overlaps/Conv%, favouring NL AD subjects over NL H speakers, demonstrating that overlaps can be considered as an indicator for a measurable difference between NL H and NL AD speakers. For the number of Overlaps/Conv, we found a statistically significant difference for the UnF NL speakers, confirming that overlap is a characteristic parameter.

<u>Summary</u>

The greatest difference in numbers, regarding our categories giving information about the ability to plan and execute an intended overlap with the aim of completing a turn-taking, was for the category Confirmations. We found higher percentages for the NL H speakers than for the NL AD speakers regarding Confirmations overlaps.
In the category Predictions, we think that the ability to predict is still preserved in AD speech and similar to the overlap behaviour of H speakers.
We were able to measure that NL AD subjects were less successful in taking the floor fully. The same observation was made for the category FaiTTC showing a small effect. The NL H speaker seemed to be able to Complete their initiated Turn-Taking more often than NL AD subjects. We suggested that due to maintaining and probably concentration difficulties of AD speakers, a full performance of a turn-taking may be limited and led to a decreased number observed for our AD subjects.
Differences in features of the category Others seemed to be measurable for each group. In the future, this category should be analysed and defined with more detail as it is a promising category for characterising AD and H speech.

We found small CL effect sizes for the F NL AD and the F NL H percentages for the categories Confirmations, Predictions, FTT and FaiTTC. In summary, we found measurable effects for each category except for Others.
Small CL effect sizes for the UnF NL AD and the UnF NL H percentages were calculated for the categories FTT and FaiTT. A large CL effect was calculated for the category Others (0.72).
We could not find an effect for the categories Confirmations, Predictions and FaiTTC for the UnF NL H and UnF NL AD percentages.

So on balance and by considering the outcome for the categories, we think that there is evidence for a measurable difference between NL H and NL AD speakers in our study. Especially in the F condition, a characterisation of certain behaviour in conversations was concrete. Parameters regarding planning as well as executing an intended overlap showed measurable effects for F NL groups.

Chapter 10 Results of the FTD study

Following the analysis of healthy and patient/AD data, we will continue with the FTD data analysis and present the overall data first (Chapter 10.1 and Chapter 10.2). We will focus on the suitability of categories to measure categorical differences and a possible Familiarity effect.
In the following sections (Chapter 10.3, 10.4 and 10.5), we will analyse the characteristics of the subtypes regarding the occurrence of overlaps in conversations (case studies). Again, we were interested in whether a Familiarity effect can be found for SD, PNFA and bvFTD. We will analyse SD (Chapter 10.3), PNFA (Chapter 10.4) and bvFTD (Chapter 10.5) conversations separately in order to show differences in conversations with regard to overlaps by comparing the data of the F and UnF condition. As we were able to record the PNFA (Chapter 10.4.2) and bvFTD (Chapter 10.5.2) patient twice, we will also report on possible changes in conversations.

10.1 FTD Study

In this subchapter, we will analyse the descriptive FTD data and provide the results for each speaker as well. In sections 10.3, 10.4 and 10.5, a qualitative analysis for the bvFTD, SD and PNFA patients will give more insight in to certain overlap behaviour.

We were interested in the conversational interaction of FTD patients in order to evaluate their behaviour regarding overlaps
1. whether the chosen categories were measurable or not in FTD speech.
2. if a Familiarity effect exists in FTD speech.

The following analysis will include the data of one bvFTD speaker (RS, male), one SD speaker (VT, female) and one PNFA speaker (BB, female). More detailed information about these speakers will be provided in the case studies in section 7.6.

<u>Number of Words/Conv</u>
The number of Words/Conv and the number of Words/Conv% are displayed in Table 103, 104 and 105. The results for each speaker are summarised in Table 104.
As shown in Table 106, the F NL PNFA patient had the lowest number of Words/Conv%, whilst the F NL bvFTD and the F NL SD subject produced almost the same percentage regarding the number of Words/Conv with 23%.

Table 104 displays that the UnF NL SD patient had a greater number of Words/Conv% with 48.16% compared to the UnF NL bvFTD and the UnF NL PNFA subjects which differed only with 3.3%.

Number of Words/Conv	Mean	StDev	Median
F NL FTD + F L FTD	798	214.54	803
UnF NL FTD + UnF L FTD	413	246.49	362

Table 103 Total number of Words/Conv for F L FTD and F NL FTD and for UnF L and UnF NL FTD data

Words/Conv	Mean	StDev	Median
F NL FTD	164.67	63.09	136
UnF NL FTD	161.13	145.58	97

Table 104 Descriptive statistics for the number of Words/Conv (FTD patients)

Words/Conv%	Mean%	StDev%	Median%
F NL FTD	20.65	4.83	23.41
UnF NL FTD	35.02	11.5	30.1

Table 105 Descriptive statistics the number of Words/Conv as percentages (NL FTD patients)

Number of Words/Conv(%)	Familiar condition	Unfamiliar condition
bvFTD	237 (23.47%)	97 (26.8%)
SD	136 (23.41%)	328 (48.16%)
PNFA	121 (15.07%)	58 (30.1%)

Table 106 Number and percentages for Words/Conv (NL FTD patients)

<u>Number of Overlaps/Conv</u>

Table 107 and 108 display the descriptive results for the number of Overlaps and the number of Overlaps for each speaker.

Overlaps	Mean	StDev	Median
F NL FTD	18.67 (31.33)	5.68 (3.79)	17 (33)
UnF NL FTD	13 (28.33)	11.79 (27.23)	10 (19)

Table 107 Descriptive statistics for the number of Overlaps. The total number of Overlaps are shown in parenthesis (NL FTD subjects)

Overlaps	Familiar condition		Unfamiliar condition	
bvFTD	25	(34)	10	(19)
SD	17	(33)	26	(59)
PNFA	14	(27)	3	(7)

Table 108 Number of Overlaps for each speaker. The total number of Overlaps are shown in parenthesis (NL FTD subjects).

Table 109 and 110 summarise the numbers of Overlaps/total number of Overlaps%. The individual results revealed a greater percentage for the F NL bvFTD patient with 73.53%. Both, F NL SD and F NL PNFA showed a percentage for the number of Overlaps/total number of Overlaps% of 51% (Table 110).

Overlaps/total number of Overlaps%	Mean	StDev	Median
F NL FTD	58.97%	12.61%	51.85%
UnF NL FTD	46.52%	5.33%	44.07%

Table 109 Descriptive statistics for the number of Overlaps/total number of Overlaps as % (NL FTD subjects)

Overlaps/ total number of Overlaps%	Familiar condition	Unfamiliar condition
bvFTD	73.53%	52.63%
SD	51.52%	44.07%
PNFA	51.85%	42.86%

Table 110 Number of Overlaps/total number of Overlaps as % (NL FTD subjects)

Table 108 shows that especially the UnF NL SD subject initiated a higher number of Overlaps (26). The UnF NL bvFTD subjects showed the highest number of Overlaps/total number of Overlaps%, with 52.63%. The UnF NL SD and the UnF NL PNFA patients differed in only 1.21% (Table 110).

We also looked at the number of Overlaps/Conv% (Table 111 and 112). By looking at the individual results, the F NL PNFA participant had the lowest number of Overlaps/Conv% with 1.74%. The highest percentage was observed for the F NL SD patient, with 2.93%.
The UnF NL SD subject had the most Overlaps/Conv% with a percentage of 3.82%, followed by the UnF NL bvFTD (2.76%) and the UnF NL PNFA (1.53%) participants.

Overlaps/Conv%	Mean	StDev	Median
F NL FTD	2.38%	0.6%	2.48%
UnF NL FTD	2.7%	1.15%	2.76%

Table 111 Descriptive statistics for the number of Overlaps/Conv as % (NL FTD subjects)

Overlaps/Conv%	Familiar condition	Unfamiliar condition
bvFTD	2.48%	2.76%
SD	2.93%	3.82%
PNFA	1.74%	1.53%

Table 112 Number of Overlaps/Conv as % (NL FTD subjects)

Number of Confirmations

Table 113 and 114 summarise the mean, StDev and median percentages as well as the individual results for the category Confirmations%. The UnF NL FTD subjects showed a higher percentage mean than the F NL FTD speakers (difference = 3.84%). The percentage medians revealed an even greater difference of 11.43%

Table 114 displays the individual results, showing a very high percentage for the F NL bvFTD patient compared to the other subjects. The difference between the F NL bvFTD and the F NL SD speakers, who had the lowest percentage of Confirmation overlaps, was 54.35%.
Under the UnF condition, the highest percentage was observed for the UnF NL PNFA subject, with 66.67%. This patient differed with 26.67% (UnF NL bvFTD) and with 43.59% (UnF NL SD) from the other two.

Confirmations(%)	Mean	StDev	Median
F NL FTD	8.33 (39.41%)	8.39 (28.75%)	4 (28.57%)
UnF NL FTD	4 (43.25%)	2 (21.98%)	4 (40%)

Table 113 Descriptive statistics for the number of Confirmations. Percentages are shown in parenthesis (NL FTD subjects)

Confirmations(%)	Familiar condition	Unfamiliar condition
bvFTD	18 (72%)	4 (40%)
SD	3 (17.65%)	6 (23.08%)
PNFA	4 (28.57%)	2 (66.67%)

Table 114 Number of Confirmations. Percentages are shown in parenthesis (NL FTD subjects)

<u>Number of Predictions</u>

The number of Predictions% regarding the means% revealed a higher number for the F NL FTD subjects than for the UnF NL FTD patients, with a great difference of 11.24% (Table 113).

Predictions(%)	Mean	StDev	Median
F NL FTD	7 (33.03%)	6.93 (23.44%)	3 (21.43%)
UnF NL FTD	3 (21.79%)	2.65 (25.61%)	4 (15.38%)

Table 115 Descriptive statistics for the number of Predictions. Percentages are shown in parenthesis (NL FTD subjects)

The individual results are summarised in Table 116. For the F condition, the F NL bvFTD speaker produced the highest number of Predictions%. The F NL SD subject was observed to initiate the lowest number of Predictions%.
Under the UnF condition, again, the UnF NL bvFTD subject showed the highest number of Predictions%. However, the UnF NL PNFA patient initiated zero overlaps of the category Predictions.

Predictions(%)	Familiar condition	Unfamiliar condition
bvFTD	15 (60%)	5 (50%)
SD	3 (17.65%)	4 (15.38%)
PNFA	3 (21.43%)	0 (0%)

Table 116 Number of Predictions. Percentages are shown in parenthesis (NL FTD subjects)

<u>Number of FTT</u>

Considering the percentages, the UnF NL FTD speakers produced a higher number of FTT% than the F NL FTD subjects. The median percentages for the F NL FTD and the UnF NL FTD participants were close (Table 117).

FTT(%)	Mean	StDev	Median
F NL FTD	12 (63.07%)	5.29 (19.76%)	14 (64%)
UnF NL FTD	8.67 (76.35%)	7.64 (2.38%)	7 (66.67%)

Table 117 Descriptive statistics for the number of FTT. Percentages are shown in parenthesis (NL FTD subjects)

Table 118 displays the individual results. The F NL SD patient showed an increased number of FTT% of 82.35%. The F NL PNFA patient had a low percentage with 42.86% for the number of FTT%.

Compared to the F NL FTD numbers%, the percentages of the individual speakers were close with a maximum difference of 3.33% between the UnF NL bvFTD and the UnF NL PNFA speakers.

FTT(%)	Familiar condition		Unfamiliar condition	
bvFTD	16	(64%)	7	(70%)
SD	14	(82.35%)	17	(65.38%)
PNFA	6	(42.86%)	2	(66.67%)

Table 118 Number of FTT. Percentages are shown in parenthesis (NL FTD subjects)

Number of FaiTT

Table 119 summarises the means, StDev and median for the F NL FTD and the UnF NL FTD speakers as well as their percentages. Considering the means%, the F NL FTD subjects showed a slightly higher percentage for the number of FaiTT%, with 36.93% and a difference of 4.28% to the UnF NL FTD mean%. The percentages for the StDev differed highly between the F NL FTD and the UnF NL FTD subjects, with a difference of 17.38%.

FaiTT(%)	Mean		StDev		Median	
F NL FTD	6.67	(36.93%)	3.21	(19.76%)	8	(36%)
UnF NL FTD	4.33	(32.65%)	4.16	(2.38%)	3	(33.33)

Table 119 Descriptive statistics for the number of FaiTT. Percentages are shown in parenthesis (NL FTD subjects)

By looking at the individual results (Table 120), the F NL PNFA subject produced the highest number of FaiTT%, whilst the F NL SD patients showed a lesser percentage.
The UnF NL FTD individual results, revealed a small difference between the highest percentage (UnF NL SD) and the lowest percentage (UnF NL bvFTD).

FaiTT(%)	Familiar condition		Unfamiliar condition	
bvFTD	9	(36%)	3	(30%)
SD	3	(17.65%)	9	(34.62%)
PNFA	8	(57.14%)	1	(33.33%)

Table 120 Number of FaiTT. Percentages are shown in parenthesis (NL FTD subjects)

Number of FaiTTC

The means% and medians% for the number for FaiTTC were higher for the UnF NL FTD speakers than for the F NL FTD subjects. However, the differences were very small.
Table 121 summarises the results.

FaiTTC (%)	Mean	StDev	Median
F NL FTD	4.33 (22.15%)	3.51 (14.19%)	4 (28.57%)
UnF NL FTD	3.33 (24.7%)	4.04 (12.79%)	1 (30.77%)

Table 121 Descriptive statistics for the number of FaiTTC. Percentages are shown in parenthesis (NL FTD subjects)

Table 122 shows the individual results for each speaker. The difference between the F NL bvFTD subjects and the F NL SD speaker was great, with 26.12%, whilst the F NL bvFTD and the F NL PNFA speakers differed only with 3.43%.

The UnF NL PNFA subjects initiated the most FaiTTC%. The lowest number was observed for the UnF NL bvFTD subjects.

FaiTTC(%)	Familiar condition	Unfamiliar condition
bvFTD	8 (32%)	1 (10%)
SD	1 (5.88%)	8 (30.77%)
PNFA	4 (28.57%)	1 (33.33%)

Table 122 Number of FaiTTC. Percentages are shown in parenthesis (NL FTD subjects)

Number of Others

The mean, StDev and median and their percentages are summarised in Table 123. The UnF NL FTS subjects showed a higher mean% than the F NL FTD speakers. The medians% revealed a higher occurrence of Others overlaps for the UnF NL FTD speakers.

Others(%)	Mean	StDev	Median
F NL FTD	1.33 (8.68%)	1.15 (7.63%)	2 (11.76%)
UnF NL FTD	3 (15.64%)	3.61 (13.08%)	2 (20%)

Table 123 Descriptive statistics for the number of Others. Percentages are shown in parenthesis (NL FTD subjects)

The individual results are displayed in Table 124. The F NL bvFTD subjects initiated zero overlaps of the category Others. The highest percentage was observed for the F NL PNFA patient.

In the UnF condition, the UnF NL PNFA patient did not initiate any Others overlaps. The UnF NL SD and the UnF NL bvFTD differed in their percentages with 6.92%, whereby the percentage was higher for the UnF NL SD patient.

Others(%)	Familiar condition		Unfamiliar condition	
bvFTD	0	(0%)	2	(20%)
SD	2	(11.76%)	7	(26.92%)
PNFA	2	(14.29%)	0	(0%)

Table 124 Number of Others. Percentages are shown in parenthesis (NL FTD subjects)

Distribution of Categorical Percentages of the number of Overlaps

We found the highest percentage in the category FTT% followed by the percentage number of Confirmations%. Greatest and similar StDev percentages were calculated for the category Confirmations% and Predictions%.
Fewer overlaps were marked as FaiTTC% overlaps. Only 12.16% of the overlaps were found in the category Others (Table 125).

	Confirmations%	Predictions%	FTT%	FaiTT%	FaiTTC%	Others%
Mean%	41.33	27.41	65.21	34.79	23.43	12.16
StDev%	22.98	22.8	12.81	12.81	12.17	10.77
Median%	34.29	19.54	66.03	33.98	29.67	13.03

Table 125 Percentages for each category (NL FTD subjects)

10.2 Discussion

We were interested in the conversational interactions of FTD patients in order to evaluate their behaviour regarding overlaps
1. whether the chosen categories were measurable or not in FTD speech.
2. if a Familiarity effect exists in FTD speech.

In the beginning of this section we were interested in showing a difference in FTD speech within the F and the UnF condition and the FTD patients' behaviour regarding overlaps. We also wanted to test if the chosen categories and measurements were able to describe and characterise FTD speech and a possible Familiarity effect.

As already mentioned, we will present and discuss the individual results in Chapter 10.3, Chapter 4 and Chapter 10.5 as case studies. In the discussion, we will refer to clinical documentation and reports which will be presented in more detail in these sections as well.
We will discuss here the overall results of our FTD patients with a comparison of the NL FTD speakers.

By comparing the percentages of the categories presenting the ability to follow the syntactical structures and processing input and the speaker's own intention of how to interact, the FTD subjects revealed a great number of feedback overlaps, but were also still able to predict upcoming TRPs. All three subjects confirmed at least twice. Overlaps of the category Predictions were initiated in all conversations, except for one patient (PNFA).
For characterising the planning and execution of speech actions (overlaps), the FTD subjects were successful in taking the floor 65% of the time. 67% of the FaiTT overlaps were Completed.
Two conversations revealed no overlaps regarding our category Others (bvFTD and PNFA).

For the number of Words/Conv, we found a greater number for the F NL FTD speakers than for the UnF NL FTD subjects, with a difference of 3.34. However, the standard deviations showed that the data were widely distributed and the difference between the individual speakers had an impact on this finding.
The standard deviation of percentage Words/Conv again showed a broad distribution, especially within the UnF NL FTD group. However, considering the percentages, the UnF NL FTD group showed a higher number of Words/Conv than the F NL FTD speakers.
The UnF NL SD subject especially had an increased number of Words/Conv% in contrast to the UnF NL bvFTD and the UnF NL PNFA speaker. The high number of Words/Conv% is due to the fact that our SD patient's speech conveys very little information (Chapter 7.6.1 for more detailed information) and that a high number of circumlocutions have led to the percentage of 48.16% for the number of Words/Conv%. This behaviour is also confirmed by the literature (Ash et al., 2009; Hoffman et al., 2014; Peelle and Grossman, 2008).

We also found that the F NL FTD speakers initiated more Overlaps than the UnF NL subjects. It may be that, with a familiar partner, the NL FTD patients are more confident in initiating overlaps as they are able to rely on the partner's conversational skill to continue the speech flow even though an overlap has occurred. However, the NL SD patient initiated fewer Overlaps in the conversation with a familiar partner compared to the recording including an unfamiliar Lead. According to the clinical documentation, this patient became more and more familiar with strangers which may have led in to an increased turn-taking trough an overlap ignoring the risk of a conversational break-down.

The percentage of the number of Overlaps/total number of Overlaps revealed a higher mean and median percentage for the F NL FTD speakers than for the UnF NL FTD speakers.
The F NL bvFTD speaker initiated the highest number of Overlaps compared to the F NL SD and the F NL PNFA patients which may represents his difficulty in judging the partner's intention of continuing her speech or the appropriateness of overlapping (Eslinger et al., 2012; Leyton and

Hodges, 2010; Peelle and Grossman, 2008). This patient showed a similar behaviour under the UnF condition, but with fewer number of Overlaps/total number of Overlaps%.
The measurement for the number of Overlaps/total number of Overlaps% revealed for the NL SD and the NL PNFA patients close values, for both, the F and the UnF condition, showing how difficult it may be to differentiate these two dementia subgroups by just analysing the number of Overlaps without categorising them.

For the number of Overlaps/Conv%, we found higher mean and median percentages for the UnF NL FTD speakers than for the F NL FTD speakers. However, the lowest percentages were found for the F NL and UnF NL PNFA speaker. The typical effortful speech in PNFA may be the reason for the smaller number of Overlaps/Conv% (Neary et al., 1998). According to (Neary et al., 1998)'s attempt at finding criteria of FTD subgroups, word-finding difficulties and word retrieval latencies result in hesitant speech and also reduce the rate of output. The risk of turn-taking during current speech may have inhibited our PNFA patient regarding initiating overlaps.
As we found greater differences between the UnF NL FTD speakers, we assume that under the UnF condition, the language and speech impairment appeared clearer than under the F condition: the bvFTD speaker showed a more compulsive behaviour (increased use of Overlaps/Conv%), the SD patient displayed a strong increase due to high numbers of circumlocutions and the PNFA patients demonstrated effortful and hesitant speech behaviour (lower number of Overlaps/Conv%).

For the category Confirmations, we found higher mean and median percentages for the UnF NL FTD than for the F NL FTD patients. Contrary to the mean percentages regarding F and UnF data distribution, the bvFTD patient had a higher percentage under the F condition. It seemed that this patient gave more feedback than the other participants, especially under the F condition. This outcome is in agreement with his familiar partners' statement that the bvFTD patient checks back and gives feedback more often than before the diagnosis. The PNFA patient showed a higher percentage for the number of Confirmations under the UnF condition (66.67%), revealing that she was able to compensate for her hesitant speech behaviour, which was confirmed by medical documentations, by initiating feedback overlaps with the UnF L PNFA partner.
Comparing the SD patient with the other patients, she initiated fewer Confirmation overlaps under both conditions. This outcome is surprising as SD speech is known as highly routinized and feedback utterances are frequently used (Peelle and Grossman, 2008).

We observed higher mean and median percentages for the number of Predictions for the F NL FTD speakers than for the UnF NL FTD subjects. All patients showed a lower percentage under the

UnF condition. In the F condition, the F NL bvFTD patient produced the most Prediction overlaps (60%) as he did in the UnF condition (50%) compared to the SD and PNFA patients. The UnF NL PNFA speaker initiated zero Predictions which may reflect her difficulty in detecting upcoming TRPs when talking with an unfamiliar person as the ability of grammatical encoding is disturbed in this FTD sub-group (Rohrer et al., 2009; Snowden et al., 2011). The PNFA patient's processing of speech and word-finding difficulties (as said in her clinical speech description) may be slower (Ash et al., 2009) and using an upcoming TRP for taking a turn cannot take place. The fact of an unfamiliar interlocutor may have worsened the situation.

The FTD data revealed higher mean and median percentages for the UnF NL FTD speakers than for the F NL FTD subjects for the category FTT. We found the highest mean and median percentages, considering all category results, for the number of FTT.
In the F condition, the F NL SD speaker showed a high percentage of 82.35%, whilst the F NL PNFA patient only succeeded to Take the Turn Fully with a percentage of 42.86%.
The outcome of higher percentages for the UnF condition may indicate that it was difficult for the patient to organise speech and follow instructions at the same time. It should be considered, however, that the speech task has been conducted first with a familiar person followed by a recording session with an unfamiliar person in order to reduce stress for the patient and becoming familiar with the task with help from their well-known partner. In the latter recording the patient may have been more confident in doing the task, which would explain her increase of FTT in the UnF condition.
Under the UnF condition, the UnF NL bvFTD speaker had the highest percentage for the number of FTT (70%) and both UnF NL SD and UnF NL PNFA speakers showed a percentage of 65 to 66%. However, all percentages are of similar order and a strong difference between the speakers could not be found.

We also presented the results for the category FaiTT. A greater number of FaiTT was found for the F NL FTD speakers.
Comparing the individual results within the F condition, we observed the highest percentage for the F NL PNFA subject (57.14%) and the lowest number for the F NL SD patient (17.65%). The F NL PNFA speaker seemed to be more willing to stop her speech than the other two subjects. The reported impairment of comprehension in PNFA speech (Gorno-Tempini et al., 2011) may lead to uncertainty in conversations in terms of confidence and continuing speech and greater hesitation. (Gorno-Tempini et al., 2011) noted that PNFS patients recognise their speech difficulties. We conclude, based on our observation, that PNFA may therefore be more willing to cancel an initiated turn. The literature supports the notes of the conversational partner in our

questionnaire. Her familiar partner reported that the PNFA patient is less fluent which may explain the tendency to stop her initiated Turn-Taking more often.
However, in the UnF condition the UnF NL SD patient showed the highest percentage for the category FaiTT, with 34.62%. The UnF NL bvFTD patient was found the have the lowest percentage (30%). The data suggest that these subtypes do not differ greatly in the category FaiTT if they talk with an unfamiliar person.
It seemed that the bvFTD patient, did not differ in his overlapping behaviour regarding Familiarity as he differed only by 6% between the number of FaiTT percentages.

We found greater mean and median percentages for the category FaiTTC for the UnF NL FTD speakers than for the F NL FTD subjects. However, the mean percentages differed only by 2.55% and in the median percentages by 2.2%.
Unlike the bvFTD patient, the SD and PNFA patients showed higher percentages under the UnF condition. The medical documentation reports that the SD and the PNFA patients, both show a more talkative behaviour towards strangers which could explain the increased percentages (see also the results for the category FTT above). Unfortunately, we did not have notes for the bvFTD patient regarding his conversational behaviour with strangers.
Looking at the F condition data, the F NL bvFTD patient showed the highest percentage for the number of FaiTTC. This patient differed by 26.16% from the F NL SD subject (5.88%), whilst the F NL bvFTD patient only showed a difference of 3.43% to the F NL PNFA patient result.
Under the UnF condition, the UnF NL bvFTD speaker revealed the lowest number of FaiTTC%. The UnF NL PNFA and the UnF NL SD patients produced percentages over 30%, whereby the UnF NL PNFA had the highest percentage (33.33%). The UnF NL bvFTD patient seemed to more rarely complete his Turn Taking as shown by his increased number of FaiTT (30%).

The category Others showed higher mean and median percentages for the UnF NL FTD speakers.
In the F condition, the F NL bvFTD subjects did not initiate any Others overlaps. The F NL PNFA speaker showed a percentage of 14.29% and the F NL SD patient a percentage of 11.76% for the number of Others.
In the UnF condition, no overlaps of the category Others were initiated by the UnF NL PNFA patient. The highest percentage was found for the UnF NL SD speaker with 26.92%. The UnF NL bvFTD participant revealed a percentage of 20% for the number of Others.

We found greater difference (>5%) in the mean percentages for the categories Predictions, FTT and Others and in the median percentages for the categories Confirmations, Predictions and Others. Considering the mean and median percentages in four of six categories, we found greater percentages for the UnF NL FTD group (Confirmations, FTT, FaiTTC and Others). A possible Familiarity effect may exist for FTD speech as well.

However, we found differences within the conditions and categories for individual speakers. Except for the category Predictions, we found for each category one patient whose data did not conform to the mean/median percentages behaviour (e.g. high for F NL bvFTD/SD and low for UnF NL bvFTD/SD, but low for F NL PNFA and high for UnF NL PNFA). One of three patients showed a contrary data distribution to the mean/median percentages for five of six categories (Confirmations: bvFTD, FTT: SD, FaiTT: SD, FaiTTC: bvFTD, Others: PNFA).

In the F condition, the categories Confirmations, Predictions and FaiTTC the bvFTD patient had the greatest percentage of overlaps. For the F NL SD patient, only the category FTT showed the highest number of Overlaps compared to the other speakers. The F NL PNFA speaker showed higher percentages in the categories FaiTT and Others than the F NL SD and F NL bvFTD speakers. The categories Predictions and FTT revealed highest percentages for the UnF NL bvFTD patient in comparison to the UnF NL SD and the UnF NL PNFA subjects. FaiTT and Others showed higher percentages for the UnF NL SD patient and the categories Confirmations and FaiTTC revealed the highest percentages for the UnF NL PNFA speaker.

<u>Summary</u>

The ability to follow the syntactical structures and processing input and the speaker's own intention of how to interact, was expressed by a great number of feedback overlaps, but our FTD patients were also still able to predict upcoming TRPs. All three subjects confirmed at least twice. Overlaps of the category Predictions were initiated in all conversations, except for one patient (PNFA). For characterising the planning and execution of speech actions (overlaps), the FTD subjects were successful in taking the floor

The results of the F and UnF condition demonstrated that it is important to differentiate the individual speakers of each subgroup as they behaved distinctively regarding overlaps.

Our findings showed that the three subgroups may be distinguishable in the number of Overlaps and regarding Familiarity. In the abovementioned discussion, we were able to link the clinic documentation as well as subjective reports from familiar partners via questionnaires with the results from our categories. The chosen categories may be able to differentiate bvFTD, SD and PNFA speech.

10.3 Semantic Dementia - Case Study

In the following sections, we will present and analyse the data of the subtypes of FTD; namely semantic dementia, progressive non-fluent aphasia and behavioural-variant frontotemporal dementia. We will focus on a differentiation of data considering Familiarity. Details and results for the SD patient are as followed:

Year of Birth: 1943
Gender: Female
Synonym for the patient: VT
Synonym for the familiar partner: RT
Synonym for the unfamiliar partner: N

Clinical note (2014): Progression of communication difficulties. Unable to provide verbal labels to a set of common objects and has similar problems with single word comprehension. She remains insightful into her condition though she perhaps does not fully understand the severity of it as her natural optimistic outlook on life has remained unchanged throughout. She is becoming more familiar with strangers.

Questionnaire (2015): Lots of words have been lost. Some replacement words are used. The partner has some understanding difficulties and eventually he does not get an appropriate answer/response. The partner has to clarify or correct what she says when she talks to others. The partner has to ask questions to understand the patient.

Subjective note by the researcher (2015): The overall impression of this patient can be characterised as highly talkative, especially with UnF persons. Her mental state was relatively well preserved, but thematic coherence appeared to be difficult.

VT initiated 17 of 33 (51.52%) overlaps in her conversation with RT (husband). The interlocutors produced 581 Words/Conv, whereas VT spoke 136 Words/Conv in total (23.41%). The transcript can be found in appendix G.
In the UnF condition, VT overlapped N 26 times (44.07%). In total, 59 overlaps occurred. The total number of Words/Conv was 681. VT produced 328 Words/Conv which was a percentage of 48.16%% of the total number of Words/Conv.

Number of Confirmations

a. Percentages

Familiar condition

VT initiated three overlaps of the category Confirmations. The proportion to the number of Overlaps was 17.65%.

Unfamiliar condition

VT used six overlaps for Confirmations which was a share of 23.08% of the number of Overlaps produced by her in total.

b. Qualitative Analysis

Familiar condition

During the conversation, VT used a small number of Confirmations. On two occasions she interrupted with short feedback. If she was addressed directly and was asked a direct question she extended her feedback as displayed in the example below. She missed a TRP and she initiated an overlap later on. In the following example, the interlocutors were discussing whether VT's map has the item Carved Stones on it or not:

VT: I haven't got a Grave [ya:rd ((very loud)) /> You next

RT: [You haven't got / okay / so I am going passed the Graveyard towards (0.17) Carved Sto:nes / you have Carved Stones (stones: 120Hz-282Hz) ?/> You next (1.6) You look at [your ((not understandable word))

VT: [Yes I have got Carved [Stones ((very loud, angry)) (.)/

RT: [Okay ((breathe in (0.25))) / so go: / <eh> / draw the line towards (0.48) Carved Stones ((stones: 109Hz-338Hz-293Hz)) /> You next then Me further (1.19)

VT: What up to there ((there: 263Hz-162Hz-174Hz)) ?/> You next (almost overlap)

Unfamiliar condition

As under the F condition, VT gave feedback in a very short manner, with no intention to continue her speech. However, again, in one occurrence, she interrupted the current speaker during a laughter preceding a flat intonation curve (turn holding signal). In this section, VT told N about her activities and recalled a conversation she had with her daughter:

VT: Then she told me / Mum (0.13) you should go there ((there: 163Hz-131Hz)) /

N: [((Laughter)) /

VT: [((Laughter)) /

N: cause you <u>might</u> like it ((like it: 142Hz, flat)) / ((laught [er)) /

VT: [Yah I love it

((it: 269Hz-297Hz-264Hz)) / (0.29)

Although an overlap took place, in this case VT interrupted in an accepted way, as it did not cause any more overlaps in the continued conversation or a break down. VT even recognised the turn holding signal, but finally decided to give feedback as soon as possible.

<u>Summary</u>

If VT wanted to provide further content to the conversation, she initiated feedback utterances either too late or was impatient to wait until the next upcoming TRP/TCU. This outcome is supported by literature about SD speech, stating that SD speech is significantly slower than healthy speech (Ash et al., 2009). This may result in a delayed reaction towards turn-taking as our observation suggests.

Regarding the percentages, VT initiated more Confirmation with N than with her husband. The difference in the number of Confirmations was 5.43%. VT may have used an increased number of Confirmations due to her progression of the disease. Our observation is in agreement with the initial clinic report which states that she has become more familiar and talkative with strangers. It may have been easier for VT to stay in conversation by using high frequency words such as feedback utterances (Confirmations).

<u>Number of Predictions</u>

a. Percentages

<u>Familiar condition</u>

VT initiated three overlaps of the category Predictions. In percentages, 17.65% of the number of Overlaps were Predictions.

<u>Unfamiliar condition</u>

VT overlapped N four times which was a percentage of 15.38% of the number of Overlaps produced by her.

b. Qualitative Analysis

<u>Familiar condition</u>

VT was still able to predict TRPs. She predicted (possible) TRPs to ask simple structured questions either at the very end of a possible TRP or by repeating her husband's words. She further replied to a closed-ended question after her husband has asked it twice. In this case, the prediction of the question-design is quite likely and was not demanding with regard to VT's ability to predict. As her grammatical encoding was preserved, syntax and also acoustic signals (increase of frequency) indicated turn-takings which she recognised and predicted correctly. In all these cases, predictions of a TRP or of an upcoming speech event (word sequence), resulting in an overlap, were not challenging to detect and the chances of taking the turn were high.

In the following, these situations will be displayed. In the first extract, VT's husband gave the instruction of drawing a line to the item "Diamond Mine" on the map. VT had difficulty in understanding the task in the first place, but could follow the instructions quite quickly after having asked several questions. Her question "Like that?" which she used as an overlap was connected to her previous question "Do this here?" and she used it as a clarification as RT did not give sufficient feedback from her point of view. Due to the fact that SD patient have difficulties with word finding, they use high frequency words rather than low frequency words, resulting in substitution for specific nouns ("it", "thing", "that"). This behaviour can make a conversation difficult in terms of speech flow and can lead to a greater need for information and details on the part of the SD patient. VT is facing this problem, too.

RT: Ya: ((255Hz-333Hz-310Hz)) (0.58) / okay ((382Hz-132Hz)) (0.22) / draw the line towards Diamond Mine ((Mine: 116Hz-148Hz)) /> You next then Me further (1.2)

VT: How would I do that ((that: 186Hz-207Hz-193Hz)) ?/> You next (0.83)

RT: With your (0.36) pen ((pen: 112Hz-120Hz-113Hz)) (1.14) / ri: [gth

VT: [Wha(0.26)t go aroun[d there

RT: [Tha:t's I la / ya that's it that's it (0.38) / [((onset sound))

VT: [Do this here ((here: 147Hz-260Hz-155Hz-180Hz)) ?/> You next (0.25)

RT: Ya just draw a line dow [n ((down: 133Hz-111Hz-169Hz))

VT: [Like that ((that: 263HZ-85Hz, flat)) ?/> You next

RT: Ya (0.13) yay a ya (0.38) / tha:t's: it ((breathe in)(0.31)) / now ((breathe in)(0.41)) I am going past the Graveyard ((Graveyard: 97Hz-112Hz)) /> (You next or Me further) (3.61)

The second time she interrupted RT's current speech for getting feedback by using a question, took place after all pieces of the instructions had been pointed out ("Cattle Stockade", "go down"). However, VT claimed RT's confirmation of her performance.

RT: Go to fortress (0.11) / no ((179Hz-253Hz-231Hz)) /

VT: No ((209Hz-186Hz)) / (0.6)

RT: No fortress ((breath in)(0.65)) / so: pass the fortress to Cattle Stockade ((stockade: 130Hz-113Hz, flat)) / (1.1)

VT: Cattle Stockade is [here /

RT: [That's right / so go down [to Cattle Stockade /

VT: [S:o I go down there ((there: 186Hz-137Hz)) ?/> You next (0.14)

VT was still able to predict possible TRP's. However, the support of her spouse during the conversation appears significant. By using requestives and repeating utterances, he ensured that VT stayed in the discussion:

RT: What's that ?/> You next (1.5)

Here (0.97) / what's th [at ?/> You next

VT: [Ravine ((235Hz-166Hz, flat)) /> You next (0.31)

Unfamiliar condition

As in the F condition, VT used direct questions, asked by N as a point of overlap in the category Predictions:

N: Ya (0.24) / so it starts there (0.61) / do you have the Highest Viewpoint ther [e ((there: 164Hz-251Hz)) /> You next then Me further

VT: [Yes ((251Hz-237Hz)) ./> You next

In the abovementioned example, VT decided to overlap instead of awaiting the predictable upcoming TRP. VT was able to predict N's question by considering not only the grammatical structure, but also the acoustic information. This conversational behaviour is still preserved and is one of the most common "methods" in order to accelerate the speech flow in terms of efficiency. Similar to her overlapping behaviour with her husband, VT initiated an overlap with substitutions, resulting in a couple of overlaps, being solved by N's use of confirmation. In the following extract, N tried to guide VT to the item "Giraffe" resulting in VT's continuous demand of feedback. However, VT was able to transfer given information and attempted to resolve her confusion through questioning in a vague manner.

N: Then down to the Giraffes ((giraffes: 209Hz-492Hz)) /> You next then Me further (2.0) [Gi-

VT: [Shall I go (0.11) down there ((there: 159Hz, flat-217Hz)) ?/> You next (0.3)

N: Ya (0.14) / my mine goes down / ya / around the G [iraffes /

VT: [Like this ((this: 200Hz-294Hz)) ?/> You next

Further, VT was able to predict laughter of N on point. She started laughing when N initiated laughter, too. In both occurrences though, N started laughing immediately after VT's utterance, which may result in the assumption that VT would have started to laugh anyway. However, time management seems to be well preserved when it comes to non-verbal communication. In the following example, VT describes a conversation she has had with her daughter about her activities, which her daughter did not like to join:

VT: Ya because my (0.49) daughter ((daughter: 213Hz-166Hz, flat)) (0.91) is: near Carl Chauton ((Chauton: 160Hz, flat)) (0.63) and she was doing that there / but she didn't like it /

N: Mhm ((207Hz, flat-87Hz, flat)) / (0.18)

VT: Then she told me Mum (0.13) you should go there ((there: 163Hz-131Hz)) /

N: [((Laughter)) /

VT: [((Laughter)) /

N: cause you might like it ((like it: 142Hz, flat)) / ((laughter))

Summary

To sum up, VT initiated overlaps based on Predictions with the support of her husband, showing her difficulties of recognizing TRPs when she needed more information or feedback. In our questionnaire, her partners stated that he has often to clarify his speech in order to keep her in conversations.

In all overlap occurrences of the category Predictions in the UnF condition, VT overlapped either almost at the end of N's utterances by considering grammatical and acoustical structures or by considering information given beforehand. The overlapping behaviour of VT showed that she was still able to predict upcoming TRPs.

Number of FTT

a. Percentages

Familiar condition

In total, 17 overlaps have been made by VT. For the number of FTT, VT initiated 14 overlaps (82.35%).

Unfamiliar condition

Under the UnF condition, VT initiated 17 overlaps (65.38%%) in the category FTT.

b. Qualitative Analysis

Familiar condition

FTT by VT can be divided into three types of overlaps:

1. Late turn-taking (overlap) after a TRP

In the following extract, RT instructed to draw a line towards the item "Diamond Mine" on the map. VT understood, but realised that she could not spot this item. It may be due to her slow processing of the instruction or to her difficulties in understanding the meaning of diamond mine that she missed the TRP after "Ya". However, she took the turn by interrupting RT's attempt to continue the conversation.

RT: You can make a line down towards Diamond Mine / right ((114Hz-251Hz, flat)) /> You next then Me further (0.2)

VT: Alright ((254Hz-295Hz-116Hz)) ./> You next (0.28)

RT: Ya ((210Hz-153Hz-227Hz, TRP)) / (1.18)

[Y

VT: [Where is Diamond Mine ((mine: 89Hz-92Hz)) ?/> You next

In the next example RT is asking about the appearance of the item Indian Country (the drawing shows tents) on VT's map. RT repeated his question and decided to continue his speech, as he did not get an answer from VT in time. However, VT may have needed more time to find the item or to link RT's description "tipi tents" to "Indian Country".

RT: You got tipi tents ((tents: 266Hz-136Hz-343Hz-317Hz)) /> You next then Me further (0.91) O you got something else there ((there: increase)) (2.64) / oka:y (0.43) / [ya

VT: [Indian Country ((country: 169Hz-189Hz)) ?/> You next

2. Using repetition to take the floor

The first example shows a conversation about the item "Cattle Stockade", its place on the map and how to include it into the journey.

VT: Cattle Stockade is [here /
RT: [That's right / so you go down [to Cattle Stockade /
VT: [S:o I go down there ((there: 186Hz-137Hz)) ?/> You next

VT repeated the instruction given by RT ("*S:o I go down* there") and took the floor out of an overlap, successfully resulting into a full turn taking.

In the next extract, VT wanted to clarify if she has to pass "Parched River" though RT did not mention it beforehand. She understood RT's instruction not to pass "Parched River", confirmed her spouse's reply with "No" and took the turn to continue the conversation.

RT: We enter the: (0.29) Bandit Territory ((territory: 110Hz-117Hz)) / (1.34)
VT: Bandit Territory /
RT: [Ya: /
VT: [Ye [s ./
RT: [So you go through [Bandit
VT: [Not Parched River (0.32) [Bed ?/> You next
RT: [Not- nothing about that /
[just Bandit [Territory
VT: [No (.)/ [shall I put up there or down ((down: 244Hz-153Hz-167Hz)) ?/> You next

3. Making herself heard

VT showed a resolute turn taking behaviour in terms of FTT if she wanted to make her point clear and heard:

RT: [((Laughter)) /
VT: [I have
RT: I don't think I ha [ve / I don't know /
VT: [I haven't got a Graveyard ((very loud)) /> You next

or if she required more information:

RT: Just draw the line / [yes

VT: [Through there ((there: 257Hz-129Hz)) ?/> You next (0.08)

RT: Ya (0.62) ya ((2.29)(drawing sound)) ri:ght /

<u>Unfamiliar condition</u>

As under the F condition, the same types of overlaps in the category FTT can be identified. But saying this, Familiarity did not seem to play a role when it came to predictability skills. However, some example from the UnF conversation will be given in the following.

In the next extract, a delayed turn taking took place when VT did need more time to process N's instruction or in other word to follow the instruction. N asked VT to go around the item "Safari Truck". VT had an additional item close to the Truck on her map and wanted feedback about including this item into her journey, which N negated.

VT: Not Overgrown <u>Gully</u> ((gully: 237Hz-141Hz-175Hz)) ?/> You next (0.07)

N: I don't have that one on my map but [that's okay /

VT: [No . /

N: we can just go around it ((it: 92Hz-247Hz)) /> You next then Me further (0.91)

<Eh [m> /

VT: [Di I just put it down [here ?/> You next

N: [Ya (0.55) / down to the Safari Truck ((truck: 91Hz-196Hz)) /> You next then Me further

VT used repetitions as a tool for getting a turn fully as she did with RT. It is typical for SD patients to have word finding difficulties (Murray et al., 2007; Neary et al., 1998; Peelle and Grossman, 2008), and VT used N's utterance to avoid a gap within the conversation. The following example displays her behaviour. At this point of the conversation, VT tried to spot the item "Springboks" on her map, obviously having difficulties with the meaning of the word. N described springboks as a type of an animal, looking like a deer that lives in South Africa.

N: I think Springboks are a type of an animal (0.33) actually ((actually: 186Hz-203Hz)) /> You next then Me further (0.19)

VT: O ri [ght ((right: 233Hz-159Hz, flat)) /

N: [Ya ((282Hz-243Hz, flat)) /

VT: Mh (100Hz-199Hz) /

N: Keep getting a lot in South Africa (((Africa: 211Hz-170Hz-371Hz)) /> You next then Me further (0.93)

VT: O [:

N: [It looked like (0.11) [deer /

VT: [In South Africa ((Africa: 330Hz-350Hz-225Hz)) ?/> You next

The third type of FTT, making herself heard, could be found in topic change rather than in "making a point" or finishing her thought. In the following example, N and VT discussed the fact that N is from London and about her accent. VT changed the topic when she got interested in N's age and took the turn out of an interruption.

N: That's good / I like it [when people

VT: [((Laughter)) /

N: can tell my acce [nt /

VT: [You are very young aren't you ((you: 151Hz-161Hz)) ?/> You next

Another FTT type VT used repeatedly was a comprehension question, such as in the following extracts.

N: And then it finishes right there ((there: 364Hz-491Hz-374Hz)) ./> You next (0.95)

VT: O that's i[t ?/> You next

N: [That's it (0.16) / I think they are pretty similar don't [you

VT: [So I put this here ?/> You next

or

VT: Shall I go <u>down</u> there ((there: 159HZ-217Hz)) ?/> You next (0.3)

N: Ya (0.14) / my mine goes down ya / around the G [iraffes /

VT: [Like this ((this: 200Hz-294Hz)) ?/> You next

<u>Summary</u>

If we compare F and UnF results, VT did not change her speech behaviour, but the conversations differed in the number of occurrences of overlaps as a percentage. The percentage of FTT was higher for the F than for the UnF condition. VT seemed to be more confident to Take a Turn Fully with her husband.

It was more difficult for VT to stay in a conversation with N rather than with RT, leading to the assumption that N was more dominant in her role of a lead: N and VT's conversation about the map started late in the conversation as VT was more interested in N's background rather than in the map task. Though it was clear to N that the task was not necessarily about completing it, she tried to get back to the map more than once during the beginning of their conversation and cut off the patient's overlaps.

Number of FaiTT

a. Percentages

Familiar condition

VT initiated three overlaps of the category FaiTT. Dividing this number by the total number of Overlaps, we calculated a percentage of 17.65%.

Unfamiliar condition

VT showed a percentage for the number of FaiTT of 34.62% (number of FaiTT overlaps = 9).

b. Qualitative Analysis

Familiar condition

FaiTT occurred when VT initiated an overlap at the same time as RT started a new turn. In two cases, she used overlaps of the category Confirmation and stopped her speech though she was giving a signal of carrying on her speech. The attempt of continuing her speech could be discerned by considering her following turn taking behaviour: taking the turn as soon as possible thereafter. Speech and turn taking have to be processed quite quickly and several automatisms are happening at the same time or closely related (Thórisson, 2002).

The next extract, which has been described in section FTT (Familiar condition), demonstrates this situation. VT first confirmed her understanding of RT's instruction, then Failed to Take the Turn, but took the floor to get the information about where to draw the line at the next given opportunity. She processed two things at the same time: first, getting further information and second, looking for an opportunity of taking the turn to get this information.

RT: Not- nothing about that / just [Bandit [Territory /

VT: [No (.)/ [shall I put up there or down ?/> You next

Another FaiTT occurred when VT had to re arrange her thought (have > have *not*), which is shown in the example below. Instead of correcting herself immediately, she stopped and took the turn later on, not considering waiting for an upcoming (possible) TRP.

RT: [((Laughter)) /

VT: [I have

RT: I don't think I ha [ve / I don't know /

VT: [I haven't got a Graveya:rd ((very loud)) /> You next

Unfamiliar condition

In the conversation of VT and N, most of FaiTTs occurred when laughing was involved. VT was not able to hold the turn after either starting to laugh:

VT: Then she told me Mum (0.13) you should go there ((there: 163Hz-131Hz)) /

N: [((Laughter)) /

VT: [((Laughter)) /

N: cause you might like it ((like it: 142Hz, flat)) / ((laugh [ter))

VT: [Ya I love it ((it: 269Hz-297Hz-264Hz)) / (0.29)

or when N was laughing first. It seemed to be difficult for VT to estimate the consequences of this non-verbal feature.

However, it should be mentioned that all "overlap laughs" involved, were FaiTTCs. There were no indicators to assume that VT wanted to continue her speech though it would have been her right. An example of FaiTT involving laughter, which caused an initiated overlap by VT, is the following. N and VT were talking about VT's doctor which both happen to know well.

N: He is a very: very: (0.2) clever man ((man: 182Hz-169Hz)) / [((laughter)) /

VT: [Ya ./

N: ((onset sound)) / (0.17)

VT: Ya ((288Hz-336Hz-228Hz)) (0.53) / he fou:nd something (0.19) / <ehm> (0.89) / to tell me (0.07) a few years ago

Other FaiTTs were detected when VT used overlaps of the category Confirmation. Again most of these FaiTTs have been FaiTTCs. A Confirmation overlap also considered as an FaiTT is displayed above as well as below. The conversational situation is described in more detail in section FTT (Unfamiliar condition).

N: I don't have that one on my map but [that's okay /
VT: [No ((decrease)) ./
N: we can just go around it ((it: 92Hz-257Hz)) /> You next then Me further (0.91)

Summary

VT caused fewer overlaps in the category FaiTT with her husband than with N (as a percentage), mirroring the different behaviour of VT: it seemed that VT was more willing to stop her initiated turns in the conversation with N may be due to new and unknown situation and her uncertainty about N's conversational behaviour.

Number of FaiTTC

a. Percentages

Familiar condition

VT initiated one overlap of the category FaiTTC. We calculated a percentage of 5.88%.

Unfamiliar condition

VT produced eight overlaps of the category FaiTTC, with a percentage of 30.77%

b. Qualitative Analysis

Familiar condition

The extract below (context in FTT (Familiar condition)) shows that VT initiated an overlap ("No"), finished her statement, though she got overrun by "Bandit". She continued with a separate question about the journey on the map immediately afterwards.

RT: Not- nothing about that / just [Bandit [Territory /
VT: [No (.)/ [shall I put up there or down ?/> You next

Unfamiliar condition

As mentioned before, all FaiTTs of VT were FaiTTCs, excluding the occurrence of an onset sound (used as an overlap), which was marked as FaiTT but not as FaiTTC.

Further, VT showed no attempt to continue after she initiated an overlap when non-verbal communication (laughter) was involved.

Summary

Comparing both conversations, more FaiTTCs initiated by VT were identified in the UnF condition than in the F condition. Saying this, it seemed that VT had more confidence to finish short turns with N than with her spouse, though it resulted in a Failure of a Full Turn-Taking.

Number of Others

a. Percentages

Familiar condition

Two overlaps were initiated by VT. We computed a percentage of 11.76% for the number of Others.

Unfamiliar condition

VT overlapped 7 times during her conversation with N which was a percentage of the number of Overlaps of 26.92%.

b. Qualitative Analysis

Familiar condition

One Other overlap was identified as a not understandable word and the other one as an onset sound. The extract below shows both overlaps. VT and RT discuss having the item "Diamond Mine" as a shared one on their maps:

RT: You haven't got a Great Rock ((breath in)(0.65)) / [what about Diamond Mine ((mine: 110Hz-96Hz-112Hz)) ?/> You next (0.95)

VT: [Ya /

Ya h [ere /

RT: [((Onset sound)) ((breathe in)(0.24)) / okay ((breath in)(0.27)) / so: we [just

VT: [((Not understandable word: 128Hz, flat)) / (0.4)

Unfamiliar condition

Three types of Others overlap occurred in the conversation VT-N.

1. Laughter (5x)
2. Not understandable word (1x)

(1)-(2) have been demonstrated already, therefore we will use the examples above as reference.

3. Editing term (1x)

Interestingly, VT only once used an editing term. Considering the underlying symptom of word finding difficulties in SD, it is surprising that word search terms such as “eh” and “ehm” did not occur otherwise.
This overlap was initiated when VT needed time to process N’s instruction of where to draw a line on the map. The fact that VT repeated N’s utterance supports the fact that she was processing the information and used “E” as a buffer:

N: Do you have the Highest Viewpoint ther [e ((there: 164Hz-251Hz)) /> You next then Me further
VT: [Yes ((251Hz-237Hz)) ./> You next (no pause)
N: So we go over there ((there: 195Hz-168Hz-375Hz)) (1.06) / and the [n:
VT: [<E> / shall I go over there and I I ya /

<u>Summary</u>
As we defined this category broadly, we did not want to provide any interpretations of the discussed overlap occurrences. However, an increased number of laughs observed for VT under the UnF condition may demonstrate that she felt comfortable speaking to N which would be supported by her clinic report.

10.3.1 Discussion

Overall, VT increased her use of overlaps when she was talking to a stranger (3.82%%) as the number of Overlaps/Conv% revealed (Overlaps/Conv% for F condition: 2.93%).

We found that VT produced more Predictions and FTT overlaps with a familiar than with an unfamiliar partner. This finding may show that especially for these categories Familiarity has an impact on VT’s conversational and overlapping behaviour. Knowing the partner’s habits regarding language may lead to a greater confidence in initiating Predictions overlaps as a conversational break down is less likely. However, the difference between the F and UnF percentages was only 2.27%. Moreover, the FTT category may reflect how much the patient is understood by the conversational partner. A familiar partner may be more willing to let the patient go on with the speech rather than stopping him or her and causing distress. VT’s husband confirmed this behaviour by saying that he often clarifies his utterances in order to keep VT in the conversation as her communication difficulties progresses.
Four of six categories showed higher percentages for the UnF condition than for the F condition (Confirmations, FaiTT, FaiTTC and Others). All these categories may be subsumed under VT’s

current condition: becoming more familiar with strangers and probably taking more conversational risks expressed by initiating overlaps. Her use of simple structured utterances due to word-finding difficulties gave these categories an increase in the observed percentages.

Differences between the F NL SD and the UnF NL SD percentages greater than 10% were found for the following categories: FTT, FaiTT, FaiTTC and Others. These categories seem to be good indicators for a possible Familiarity effect in SD speech.

10.4 Progressive Non-Fluent Aphasia - Case Study

Personal details and the results of the progressive non-fluent aphasia patient recording will be presented in this section. As we were able to record this patient twice, we will also compare the data from the initial and second recording.

Year of Birth: 1948
Gender: Female
Synonym for the patient: BB (MMSE: 28/30, 09/2014)
Synonym for the familiar partner: JB
Synonym for the unfamiliar partner: KH

Clinic note (2014): She has a slight hesitancy of speech and occasional word-finding difficulties and these are more marked when she is out of her comfort zone for example if out shopping and talking to strangers.

Questionnaire (2015): Her speech is less fluent. Her husband has to explain occasionally what he meant or has to use different words. Further, he helps out when the patient has difficulties in conversations with others. Often, he replies to support her.

Subjective impression by the researcher (2015): The overall impression of this patient can be characterised as highly talkative, especially with UnF persons. Her mental state was relatively well preserved, but thematic coherence appeared to be difficult.

In the F condition, BB and JB used. 27 overlaps. This conversational group spoke 803 Words/Conv. BB initiated 14 overlaps (51.52% of the total number of Overlaps) and produced 121 Words/Conv (15.07%). The transcript can be found in appendix H.

BB and KH (UnF partners) overlapped each other 7 times, whereas BB produced three (42.86%) of these overlaps. The UnF interlocutors produced 196 Words/Conv, whereby BB showed a share of 30.1% (59 Words/Conv).

Number of Confirmations

a. Percentages

Familiar condition

BB initiated four Confirmations overlaps, which was a percentage of 28.57% of the number of Overlaps.

Unfamiliar condition

BB overlapped KH two times. We computed a percentage for the number of Confirmations of 66.67%.

b. Qualitative Analysis

Familiar condition

In three of four cases BB initiated a Confirmation overlap at the very end of JB's turn (either possible TRP or TRP).

An example is given in the following extract. JB described the way of passing the item Ravine via north. BB initiated a Confirmation at a possible TRP.

JB: Ya so we pass by the Ravine / north Ravine / [the Ravine /

BB: [((Onset sound))

JB: so you are going to drive that wa [y /

BB: [Ya /

JB: north of the Ravine ((ravine: 98Hz-134Hz-81Hz, flat) /> You next then Me further

In one case she confirmed, not waiting for a TRP. However, it can be assumed that BB expected JB to finish. JB decided to add a sequence, which was not predictable for BB. In the given situation, BB guided JB towards the Finishing line. Difficulties arose because JB could not follow his instructions and got upset.

BB: This is v- very an- anno [n-

JB: [Well / I don't understand it either [too well /

BB: [No /

JB: but there you are is / <ehm> / (1.6)

Unfamiliar condition

In BB's conversation with KH, she initiated an overlap of the category Confirmations due to delayed turn taking. In both overlap occurrences, BB seemed to misinterpret KH' expectations. In the first overlap, BB took the turn to an obvious turn giving (increase of frequency, time span of 0.96s) too late:

KH: All the way along (0.41) / and then (0.67) up over the (1.57) mountain ((mountain: 419Hz-221Hz-257Hz)) /> You next (0.96)

A [nd then (0.4)

BB: [Ya ./> You further

The second occurrence of a Confirmations overlap was initiated due to the fact that BB did not react in time to an awaiting position. KH did reply to BB's feedback question and expected her to continue her speech.

BB: <E> / the / <e> / the: Giraffes did you say ((say: 99Hz-229Hz)) (?)/> You next (0.25)

KH: Yes (0.16) / ya (269Hz-240Hz) ./> You next

T [o

BB: [Ya ((134Hz, flat)) / (0.35)

Summary

Whilst in the F condition, BB was able estimate the end of JB's turn and overlapped by using Confirmations in an appropriate way, which did not cause any conversational break-downs. With KH as conversational partner, BB seemed to have difficulties confirming in time and caused overlaps after TRPs, which led to a short gap. As mentioned above, BB has speech difficulties if she feels out of her comfort zone probably leading to hesitancy in speech as observed in our data.

Number of Predictions

a. Percentages

Familiar condition

BB overlapped JB three times with a percentage of 21.43% for the number of Predictions.

Unfamiliar condition

BB did not cause any overlaps of the category Predictions (0%).

b. Qualitative Analysis

Familiar condition

All overlaps caused by predictability were Confirmation overlaps, initiated at possible TRP's except the one already mentioned above in section "Number of Confirmations".

Another example of an overlap of the categories Confirmation and Prediction is shown below. BB predicted that JB would finish the utterance and also predicted which item JB was talking about. However, the overlap was initiated late, therefore we could also assume timing difficulties in BB's speech organisation.

JB: We re going to drive alo:ng the coast (0.26) / on the Crane Ba [y / (0.3)
BB: [Mhm ((very quiet))

Unfamiliar condition

BB did not initiate any overlap in the category Predictions.

Summary

It seems that BB was more hesitant in her speech behaviour in her conversation with KH when it came to overlaps in the category Predictions (again, this behaviour is confirmed by the clinic report). Processing grammatical structures and the organisation of her intentions at the same time may have limited BB's conversational behaviour in terms of predictability.

However, the ability to predict possible TRPs was still preserved as she was able to predict possible TRP's with her husband and to initiate feedback overlaps.

Number of FTT

a. Percentages

Familiar condition

BB succeeded in Taking a Turn Fully out of an overlap six times. The computed percentage for the number of FTT was 42.86% in the F condition.

Unfamiliar condition

BB initiated two FTT overlaps in a conversation with the UnF partner. The percentage for the number of FTT was 66.67%, considering the number of Overlaps (3).

b. Qualitative Analysis

Familiar condition

Two types of overlaps in the category FTT could be found.

1. Making herself heard by initiating topic change
2. Taking the turn at a possible TRP

1. Making herself heard

BB took the turn out of an overlap when she wanted to get information about something that had been mentioned previously, appearing at that point to be a topic change. The following extracts show this type of overlap.

BB interrupted JB to get clarification about the map task: whilst JB was explaining the task, BB referred back to an item ("And *that one* was, it's non there") described by JB earlier in the conversation ("Ravine").

JB: The we are going to town (1.47) / left (2.35) / we drive (0.26) left / ((1.52)(drawing))

BB: But there is different things in there ((there: 126Hz-133Hz)) ?/> You next (0.11)

JB: Ya (0.22) ya (0.14) that's alright (0.46) / we don't need to worry about is is (0.34) ulti [matively

BB: [And that one was (0.1) it's non there ((there: 180Hz-138Hz)) ?/> You next

In the following extract, JB instructed BB to pass the item "Ravine", but BB changed the topic by introducing a new item, which hadn't been mentioned before. Her attempt at taking the turn fully out of an interruption was successful.

JB: We are going to go close to the Ravine (0.41) / that's it (0.8) / you go there (0.15) / [pass th-

BB: [((Onset sound)) (0.18) / [((onset sound))

JB: [Pa (0.19) / the [re is

BB: [We are going to the Carpenter's ((carpenter: 202Hz-209Hz)) ?/> You next

Besides FTT overlaps including a topic change, BB initiated an FTT overlap (or interruptions) when she wanted to get her point across. In the extract below, this conversational behaviour resulted in one overlap after another, finally resolved by JB's stepping back by using confirmation ("Ya").

JB: It's called Tilled Land (0.68) / Tilled Land / whatever that means ((means: 101Hz-125Hz)) /> You next (1.32)

BB: Tilled Land / ya / wh- [peop-

JB: [Livi [ng

BB: [the farme [rs

JB: [Ya /

BB: t- turning in all the (0.4)

JB: The soil ((soil: 141Hz-118Hz)) ./> You next

Evaluating the examples, it became clear that effortful speech and grammatic errors were observed and resulted in difficulties in turn-taking behaviour. It seemed to be difficult for BB to process both, current speech and her need for understanding instructions, so that FTT overlap occurred when she wanted to make herself heard.

2. Taking the turn shortly before a possible TRP

In the extract below, BB initiated a FTT overlap by interrupting BB's description of where to find the item "Boat House". BB was able to predict the possible TRP and took the floor shortly before the turn became available. It seemed that she wanted to speed up the speech flow at this point. This strategy fits within the overall expression, the patient has made: she got quickly upset about hesitations and gaps within the conversation.

JB: There is a Boat House (0.12) the [re ((there: 135Hz-105Hz)) /

BB: [Yes / so shall I put

JB: Put a ((not understandable word))

Unfamiliar condition

Both occurrences of FTT overlaps happened shortly before a possible upcoming TCU. The overlaps were initiated by BB to demonstrate her understanding of the instructions as the example below from the very beginning of the conversation shows.

KH: So we gonna start (0.37) that looks cross / that's the star [t
BB: [This one here ya ((ya: 189Hz-209Hz)) ?/> You next

Summary

Interestingly, no topic changes occurred within BB's conversation with the UnF person. However, under both conditions, BB used an FTT overlap when a TRP was coming up. As shown above, she was still able to predict speech behaviour and intentions quite well.

Number of FaiTT

a. Percentages

Familiar condition

Eight FaiTT overlaps were produced by BB. The percentage for the number of FaiTT was 57.14%.

Unfamiliar condition

Only one overlap of the category FaiTT was shown for BB in her conversation with KH. As a percentage, 33.33% of the number of Overlaps was made in the category FaiTT.

b. Qualitative Analysis

Familiar condition

FaiTT occurred when BB tried to refer back or to repeat previously mentioned sequences to be able to follow JB's instructions. The following extract displays BB's attempt to follow instructions but getting interrupted or overrun by JB.

JB showed BB on her map where to find the item "Crane Bay" and "Boat House". However, he noticed that the latter was missing on BB's map, leading BB to initiate a question about the location of "Crane Bay". She stopped her attempt when she realised that JB would provide further information:

JB: And there is Crane Bay ther- / <e:> / is a Boat House just there (0.19) / I do [n't see it ((it: 147Hz-130Hz-156Hz)) /> You next or Me further (2.59)

BB: [Is:- / <e> /

JB: There is a Boat House (0.12) the [re ((there: 135Hz-105Hz)) /

BB: [Yes / shall I put

JB: Put [a ((not understandable word))

BB: [a boa-

JB: ((not understandable word)) or something box / <e:> /a Boat House there / you know / that's it /> You next then Me further

Other FaiTTs coincided with overlaps of the category Confirmations, see examples above.

Unfamiliar condition

In the conversation with KH, BB overlapped resulting in a FaiTT when she confirmed KH. KH recognised BB's attempt to take the turn, stopped and continued after a gap of 0.4s. However, BB has completed her utterance (FaiTTC), but did not continue, leading in to an FaiTT overlap.

KH: All the way along (0.41) / and then (0.67) up over the (1.57) mountain ((mountain: 419Hz-221Hz-257Hz)) /> You next (0.96)

A [nd then (0.4)

BB: [Ya ./> You further

KH: you are going down (0.19) to the (0.39) Safari Truck ((truck: 264Hz-247Hz)) /> You next then Me further

Summary

Under both conditions, BB initiated mainly Confirmations, which also got marked as an FaiTT overlap. It became clear that BB used simple structured utterances or phrases in order to stay as an active interlocutor in the conversation even if she did not take the floor. However as the next section will show, all FaiTT overlaps have been Completed.

Number of FaiTTC

a. Percentages

Familiar condition

For BB, we found 4 overlaps in the category FaiTTC. Accordingly, the percentage for the number of FaiTTC was 28.57%

Unfamiliar condition

One overlap of the category FaiTTC occurred during BB's speech (33.33% of the number of Overlaps initiated by the PNFA patient).

b. Qualitative Analysis

Familiar condition

All Confirmational FaiTT overlaps have been marked as FaiTTC overlap. One FaiTTC overlap was initiated by BB, once she understood JB's instruction and description ("O:"). No attempt of continuing could be observed.

JB: That is one / there is two Boat Houses you see / there is [one
BB: [O: ./
JB: Boat House and another one just there (0.98) / at the tip of the Crane Bay (0.19) / there is a Boat House there ((there: 133Hz-165Hz)) /> You next then Me further (2.92)

Unfamiliar condition

The Confirmational FaiTT overlap, described above has been marked as FaiTTC. This overlap has been the only one in the category FaiTTC.

Summary

To sum up, BB seemed to Fail in her Turn Taking attempts, but considering the category FaiTTC, her success in completing her turns is great nonetheless.

However, the chances that Confirmation overlaps are FaiTTCs is high and therefore the high occurrence is not unusual; If an interlocutor intends to give only feedback whilst the other one is talking, this sequence will be completed immediately after.

Number of Others

a. Percentages

Familiar condition

Two overlaps of the category Others have been produced by BB which was a percentage of 14.29% of the number of Overlaps.

Unfamiliar condition

No overlaps of the category Others were made by BB.

b. Qualitative Analysis

Familiar condition

Onset sounds were marked as Others overlaps in the conversation with BB and JB and are shown below:

JB: Ya so we pass by the Ravine / north Ravine / [the Ravine /
BB: [((Onset sound))
JB: so you are going to drive that wa
[y /
BB: [Ya /

and

JB: We are going to go close to the Ravine (0.41) / that's it (0.8) / you go there (0.15) /
[pass th-
BB: [((Onset sound)) (0.18) / [((onset sound))
JB: [Pa (0.19) / the [re is
BB: [We are going to the Carpenter's ((carpenter: 202Hz-209Hz)) ?/> You next

10.4.1 Discussion

The PNFA patient showed a higher percentage of Overlaps/Conv when she was talking with a familiar partner than with a stranger. The difference between the percentages was 0.21%.

For the categories Predictions, FaiTT and Others, greater percentages for the F than for the UnF condition were found.

Being familiar with the conversational partner seemed to play a greater role for the PNFA patient when it came to predictability and the willingness to stop an initiated overlap. The probability of high occurrences of gaps and pauses may be low if talking to a familiar person as the risk of a conversational break-down is low. This fact might have encouraged BB to initiate overlaps of the category Predictions more often with her husband. The parallel processing of grammatical structures and intentions of someone BB was not familiar with may have also been a reason for the higher percentage of Predictions produced under the F condition (difference = 21.53%). A high rate of FaiTT overlaps under the F condition may indicate a greater acceptance of JB's leading role. However, we found that all FaiTT overlaps were Completed, revealing that though her utterances were short, she was able to finish her initiated overlaps.

The categories Confirmations, FTT and FaiTTC revealed higher percentages for the UnF than for the F condition. In particular, the category Confirmations revealed a great difference between the F and UnF percentages (38.1%) indicating that BB used feedback as a main feature of being able to take part and stay in the conversation with an unknown person. However, it seemed that BB was more confident in terms of Taking a Turn Fully with an UnF partner. This may also be a result of a specific conversational behaviour of KH who provided BB time to express her thoughts and accepted an overlap more willingly.

We found differences between the percentages for the F and UnF condition greater than 20% for the categories Confirmations (38.1%), Predictions (21.43%), FTT (23.81%) and FaiTT (23.81%). Our observation demonstrates that a Familiarity effect is able to discriminate and characterise PNFA speech.

Nonetheless, it should be noted that the UnF conversation was very short and the percentages should be treated carefully in terms of interpretation.

10.4.2 Progressive Non-Fluent Aphasia: Comparison of First and Second Recording

BB and JB agreed to participate in a second recording session 5 months after the first recordings. The clinic documentation did not change at the point of the second recording session.

Subjective impression: Her word finding difficulties had worsened and she got upset quite quickly during the conversation due to her limited grammatical abilities. Further, she had problems following and understanding the instructions given by her husband JB.

Data and Percentages

	PNFA data I	PNFA data II
Total number of Words/Conv	803	882
Words/Conv(%)	121 (15.07%)	198 (22.45%)
Overlaps/ Conv	14 (27)	8 (25)
Overlaps/Conv%	1.74%	0.91%
Overlaps/total number of Overlaps in%	51.85%	32%

Table 126 Number and percentages of Words/Conv, Overlaps/Conv and Overlaps/total number of Overlaps (PNFA I and PNFA II).

Table 126 shows that the number of Words/Conv% increased, comparing first and second recording data, with a difference of 7.38%.

During the second recording session, BB got very inpatient as she did not fully understand the speech task and got more involved in the conversation resulting in a higher percentage for the number of Words/Conv.

By considering the number of Overlaps/Conv%, we found a lower number in the second recording for BB. She only overlapped 0.91% of the total number of Words/Conv, revealing that though her participation in the conversation increased, she overlapped less often. This finding may indicate that her inner drive to take active part in the conversation had decreased and the effort of continuing the speech flow had become the responsibility of her husband e.g. by holding back to give BB room for her speech.

Number of Confirmations

Confirmations(%)	PNFA data I	PNFA data II
BB	4 (28.57%)	3 (37.5%)

Table 127 Number of Confirmations. Percentages are shown in parenthesis (PNFA I and PNFA II)

In total, more overlaps of the category Confirmations were initiated. Table 127 shows that BB initiated more Confirmations% in the second than in the first recording. It may have become necessary for BB to use simpler speech and short frequent utterances in order to stay in the conversation.

Number of Predictions

Fewer overlaps in the category Predictions were initiated during the second recording session as shown in Table 128. The dominant leading behaviour of JB did not provide possible upcoming TRPs.

However, the transcript for the second recording revealed that BB was either not able to detect upcoming TRPs or was not interested in contributing to the conversation by using the feature Predictions.

Predictions(%)	PNFA data I	PNFA data II
BB	3 (21.43%)	1 (12.5%)

Table 128 Number of Predictions. Percentages are shown in parenthesis (PNFA I and PNFA II)

Number of FTT

FTT(%)	PNFA data I	PNFA data II
BB	6 (42.86%)	4 (50%)

Table 129 Number of FTT. Percentages are shown in parenthesis (PNFA I and PNFA II)

The number of Overlaps increased as can be seen in Table 129. Considering the percentage, BB succeeded in FTT% overlaps more often in the second recording than in the first one, with a difference of 7.14%.

By looking at the transcript of the second recording, it can be seen that she missed a couple of (possible) TRPs, resulting in long utterances by JB, who tried to continue the conversation by motivating BB to participate in the conversation using requestives. JB may have given BB much freedom in order to let her contribute to the conversation.

Number of FaiTT

FaiTT(%)	PNFA data I	PNFA data II
BB	8 (57.14%)	4 (50%)

Table 130 Number of FaiTT. Percentages are shown in parenthesis (PNFA I and PNFA II)

Comparing the number of FaiTT% overlaps (Table 130), BB decreased the occurrence of FaiTT overlaps during the conversation in the second recording session. She was perhaps less willing to stop her turn out of an overlap, because she could not come across with her thoughts during the conversation. This may have been due to the fact of her partner's conversational behaviour was very dominant in the lead. The example below shows an example of JB's speech organisation:

BB: Where thi [s ((this: 120Hz-467Hz)) ?/> You next
JB: [There / and [then you
BB: [We could
JB: got to the Finish / that's it ((it: 132Hz-172Hz)) ./> You next (1.39)
And that's you finish / ya that's it / Finish / whatever Finish is (0.75) / you know the Finish / where is the Finish BB ?/> You next (0.94)

JB seemed aware of the tense situation and he appeared to try to approach the conversation by providing his wife with as much information as possible.

Number of FaiTTC

The number of FaiTTC% decreased by only 3.57% (Table 131). Both FaiTTC overlaps, initiated during the second conversation, have been Confirmation overlaps as well. Simple structured utterances and phrases were used by BB to complete turns in the first and second recording.

FaiTTC(%)	PNFA data I	PNFA data II
BB	4 (28.57%)	2 (25%)

Table 131 Number of FaiTTC. Percentages are shown in parenthesis (PNFA I and PNFA II)

Number of Others

Others(%)	PNFA data I	PNFA data II
BB	2 (14.29%)	1 (12.5%)

Table 132 Number of Others. Percentages are shown in parenthesis (PNFA I and PNFA II)

In the first as in the second recording session, all overlaps (Table 132) in the category Others were marked as onset sounds. We were not able to provide any more detailed information about the category Others at this point.

10.4.3 Discussion

We found increased percentages from the first to the second recording for two categories: Confirmations and FTT. All other categories showed a decrease in the percentage for the PNFA patient.

Differences in the percentages between the first and second conversation were highest for the categories Confirmations (difference = 8.93%) and Predictions (difference = 8.93%). A difference in the percentages of 7.14% was found for the categories FTT and FaiTT.

The smallest difference between the first and second recording was found for the category Others (difference = 1.79%).

Based on our findings, we may say that for this PNFA patient, the change over time was mainly a decrease in the number of Overlaps. An increase of Confirmations overlaps may be explainable by the simple processing and production of feedback utterances which allow a contribution to the conversation with less effort. The reason for the higher number of FTT in the second recording can be found in the JB's conversational behaviour. He motivated and encouraged BB even more in the second recording as her symptoms had worsened, leading to a cautious speech behaviour in order to allow BB to articulate her thoughts in her own time.

10.5 Behavioural-Variant Frontotemporal Dementia - Case Study

The following sections will show the results of the bvFTD patient. As we were able to record the bvFTD patient twice, we will also report on possible changes in conversations.

Year of Birth: 1948

Gender: Male

Synonym of the patient: RS

Synonym of the familiar partner: AS

Synonym of the unfamiliar partner: SK

Clinic note (2014): Addenbrooke's Cognitive Examination- Revised (ACE-R)[4] result = 84/100.

Questionnaire (May 2014): Patient's speech is slightly hesitant and often asks questions back to his spouse. The conversations go mostly smoothly. He does interrupt if he is in a room full of people and needs to check back with me.

Subjective impression by the researcher (May 2014): RS seemed to be very active in his speech behaviour and highly talkative with the researcher. In the conversation with his wife, he behaved more reluctantly than with the unfamiliar person. It was highly recognizable that the partner, AS, dominated the recorded conversation and asked many feedback questions (closed and open) to keep her husband talking and integrate him into the speech task.
Completely different was the conversational structure between RS and SK. Both seemed to be equal partners in terms of number of word usage.

In the F condition, the interlocutors spoke 1010 Words/Conv and initiated 34 overlaps. RS produced 237 Words/Conv and had an overlap occurrence of 25 (73.53%). RS' percentage for the number of Words/Conv was 23.47%. The transcript can be found in appendix I.
The UnF speakers, RS and SK, initiated 19 overlaps in total. Their conversation consisted of 362 Words/Conv, whereby RS spoke 97 Words/Conv. The percentage for the number of Words/Conv was 26.8%. RS initiated 10 overlaps (52.63%).

[4] http://www.stvincents.ie/dynamic/File/Addenbrookes_A_SVUH_MedEl_tool.pdf

Number of Confirmations

a. Percentages

Familiar condition

RS produced 18 overlaps of the category Confirmations which was a percentage of 72% of the number of Overlaps.

Unfamiliar condition

In the UnF condition, RS overlapped four times, with a percentage of 40% of the number of Overlaps.

b. Qualitative Analysis

Familiar condition

Most overlaps in the category Confirmations were initiated shortly before a (possible) TRP. A reason for the high number could be poor mental organisation and limited planning ability (Ash et al., 2009).

If RS set a Confirmation at a TCU, and he took the turn with a feedback sequence, he usually stopped afterwards causing difficulties for AS in continuing the conversation. The example below shows a situation as described. RS and AS were discussing where the item “Picked Fence” can be found on the map:

AS: You got Picked [Fence ?/
RS: [Ya / is that on my left hand side ((side: 133Hz-123Hz-337Hz)) ?/> You next (almost overlap)
AS: That’s way on my lef [t ((left: 132Hz, flat)) /
RS: [Okay ./> You next (0.98)
AS: Cause I am passing / my pass goes quite near the Youth Hostel /> You next then Me further

On only a few occasions, he overlapped with a Confirmation before a possible TRP, within a sequence, which did not cause any trouble and could be judged as appropriate *You more* signal. The extract below shows such an occasion.

AS: I precede on pass the the Disused Monastery / which is really crumbling falling dow [n and that’s on my le:ft ((left: 197Hz-219Hz-121Hz)) /> You next then Me further (1.95) ((drawing noise))
RS: [Mh /> You more

RS also overlapped shortly after a (possible) TRP, in most cases due to time management difficulties.

In the following example, AS described for quite a while her journey on the map, giving a couple of opportunities of turn giving, which RS did not take. When he finally confirmed, it clashed with an editing term by AS, who was then awaiting for RS to say more. However, RS gave the signal *You next*, completing his turn.

AS: You start drawing follo:wing the line (1.04)/ and then I'm (0.61) preceding on (0.59) / a:nd (0.61) down (0.35) / I s: (0.19) then begin to pass the Parked Van / he's got (0.46) / I don't know / it's git something in there / but I think he is delivering something (1.19) / then I turn round (0.55) behind the back of him (2.24) / a:nd (1.75) to my right I can see: some yachts (0.16) / on a: harbour on a: harbour on a lake sort of thing / but it looks like is it a Yacht Club because it's a nice (0.48) little (0.1) / [<ehm> /

RS: [Mhm / okay ((299Hz-117Hz)) ./> You next (0.28)

AS: Club house there (0.77) / anyway I precede on behind this Parked Van /

Unfamiliar condition

In the conversation with SK, overlaps occurred either at almost the end of a sequence or at the end of a possible TRP. This suggests RS's time management is still well preserved and appropriate (Seedhouse, 2004).

Looking at the first overlap type, the following extract shows that RS was able to predict and to confirm shortly before a completed sequence, not causing any conversational difficulties. However, in two of three cases, RS benefitted from the fact that items had been mentioned already in the conversation and therefore he was not demanding to confirm before a TRP, including or referring back to this item, came up.

SK: And then we gonna go: (0.74) / <e:m> (1.53) / around the Bakery ((bakery: 245Hz-414Hz)) / have you got a B [akery ?/> You next then Me further

RS: [Ya I got Bakery here /> You next

The abovementioned on-point feedback overlap at a possible TRP is shown in the following extract. RS initiated an overlap of the category Confirmation when SK decided to add a detail to her statement. This overlap occurred at the beginning of the conversation and may have been caused by unfamiliar conversational behaviour, which had not been adjusted to yet by RS and SK.

SK: On the left hand side of the Cliffs / [as we look at them ((them: 121Hz-313Hz-238Hz)) /
RS: [Ya ./> You more

Summary

In summary, the underlying structure (timing) of Confirmation overlaps was under both conditions similar. The percentage number of Confirmations between the F and UnF conversations may have differed due to the conversational behaviour of RS's partners. Whilst SK was more cautious and observed RS's speech carefully, AS's speech strategy led to time management difficulties for RS, who possibly suffered from processing difficulties and reduced speech fluency (Ash et al., 2009).

Number of Predictions

a. Percentages

Familiar condition

RS initiated 18 Predictions overlaps, with a percentage of 60 of the number of Overlaps.

Unfamiliar condition

RS produced five overlaps of the category Predictions. We calculated a percentage of 50 for the number of Predictions of the number of Overlaps for the bvFTD patient in the UnF condition.

b. Qualitative Analysis

Familiar condition

As indicated in the section above, RS was able to predict TCUs and possible TRPs. An example is shown below. Here, AS and RS were discussing the location of the item Flight Museum on AS' map.

AS: And which side is the- (0.65) line is tha [t ((that: 162Hz-90Hz)) ?/> You next
RS: [On the right hand side of it ./> You next

The following examples show not only that RS predicted an upcoming TRP, he was also able to predict a previously mentioned item and to decode the grammatical structure by expecting a question.

In the part of the conversation shown below, AS described the way from the item "Alpine Garden" towards the Youth Hostel, finishing her utterance with a closed question.

AS: And then (0.4) just beyond the Alpine Garden I am gonna turn ri:gh [t ((right: 193Hz-135Hz)) /> You next then Me further

RS: [Okay ((165Hz-116Hz)) ./> You next (1.39) ((drawing))

AS: And then after a short time I turn le:ft (0.77) / so that the Youth Hostel is now on my right / an you see a Youth [Hostel ?/> You next then Me further

RS: [No there isn't one ((one: 123Hz-137Hz)) ./> You next

The next extract shows a delayed turn-taking by RS leading to overlaps, solved by RS's prediction of AS's question about having the item "Picked Fence" on his map.

AS: I'm then turning to my right (2.08) / but on that road I can see to my lef:t (0.77) there is a Fence a Picked Fenc:e ((fence: 170Hz-127Hz)) /> You next (0.79)

RS: Y [es /

AS: [You got a Picked [Fence ?/> You next

RS: [Ya / is that on your left hand side ((side: 133Hz-123Hz-337Hz)) (?)/ You next then Me further

Unfamiliar condition

In the conversation with SK, RS showed the same underlying structure of overlaps in the category Prediction as with his wife. RS initiated overlaps shortly before (possible) TRPs came up and was able to predict items by either repeating them:

SK: And then we gonna go: (0.74) / <e:m> (1.53) / around the Bakery ((bakery: 245Hz-414Hz)) / have you got a B [akery ?/> You next then Me further

RS: [Ya I got Bakery here /> You next

or by predicting the item as they have been mentioned earlier in the conversation: SK and RS were discussing of how to pass the item "Forge" which was missing on RS's map. The location of the items "Old Pine" and "Wheatfields" were used to locate "Forge" on the map.

SK: Old Pine / yes / so is in betwee:n is just below the Cliffs until the left of the Pine ((pine: 185Hz-204Hz-106Hz, flat)) /> You next (3.17) ((drawing noise))

RS: <Em> (1.24) / I got Wheatfields / that's that's [what I thought ((thought: decrease)) ./> You next (0.31)

SK: [S:

Ya / so it's (0.8) north of the: (0.52) north of the (0.77) Wheatfields (0.53) / left of the Old [Pi:ne ((pine: 210Hz-220H)) /> You next then Me further

RS: [Ya / I like that /> You next

Remarkably, he processed information very quickly when the sequence was highly predictable such as the first sound of a confirmation has been initiated ("Ya"):

RS: Warehouse / that's north of that /> You next then Me further (0.13)

SK: Y [a /

RS: [So I cross there a line like that ./> You next

Summary

Finally, it was observed that RS initiated overlaps in the category Predictions in both conversations with a similar timing strategy about when to start his speech. He initiated more overlaps in the conversation with his wife than with the unfamiliar person. However, the difference in the percentages was not great at 10%.

Number of FTT

a. Percentages

Familiar condition

RS initiated 16 overlaps that resulted in FTT overlaps. In percentage, 64% of his overlaps were overlaps of the category FTT.

Unfamiliar condition

In the UnF condition were seven FTT produced by RS which was a percentage of 70 of the number of Overlaps.

b. Qualitative Analysis

Familiar condition

RS initiated an FTT overlap when two situations took place: First, when questions were involved, either his questions or when he answered them. Second, he initiated FTTs out of an overlap of the category Confirmation.

When RS decoded the grammatical structure of a question-like sequence, he tended to initiate an overlap with a FTT intention. For the majority of questions, he did not wait for a TRP to come up. The following extract, from the end of the conversation, shows an example.

AS: Have you got anything else that you noti [ce ((notice: 167Hz-150Hz)) ?/ You next

RS: [No (0.18) / okay (0.52) / stop there ((there: 310Hz-288Hz)) ?/> You next

The example below displays another example for grammatical decoding, resulting in a FTT overlap:

AS: Alright ya (1.03) / but befo:re the Level Crossing is there anything before the Level [crossing ?/> You next

RS: [Telephone Box on the right hand side ((side. 356Hz-331Hz)) ./> You next

When RS wanted to get further information, he was persistent in doing so and took the turn by interfering with a question:

AS: And then I'm preceding o:n (0.33) / [and

RS: [So hang on / should I should I start drawing ((drawing: 184Hz-286Hz)) ?/> You next

Most FTTs have been causes by an initiated Confirmation overlap (11 of 16). RS used feedback as an opportunity of taking a turn and to continue his speech. The example below demonstrates how RS first recognised an upcoming question, overlapped with a Confirmation ("No") and Took the Turn Fully.

AS: And then after a short time I turn le:ft (0.77) / so that the Youth Hostel is now on my right / an you see a Youth [Hostel ?/> You next then Me further

RS: [No there isn't one ((one: 123Hz-137Hz)) ./> You next

The following shows another example of the strategy "Confirmation > FTT overlap":

AS: Have you anything else: [which I haven't mentioned on the

RS: [No: /

Probably no[t ./

AS: [Ma [p ((map: 140Hz-130Hz)) ?/> You next

RS: [No (0.11) / okay /

Unfamiliar condition

RS showed the same turn-taking behaviour for the category FTT as he did in the conversation with his spouse. He initiated FTTs out of Confirmations overlaps:

SK: Ya / so it's (0.8) north of the: (0.52) north of the (0.77) Wheatfields (0.53) / left of the Old [Pi:ne ((pine: 210Hz-220H)) /> You next then Me further

RS: [Ya / I like that /> You next

and when questions were involved:

SK: And then we gonna go: (0.74) / <e:m> (1.53) / around the Bakery ((bakery: 245Hz-414Hz)) / have you got a B [akery ?/> You next then Me further

RS: [Ya I got Bakery here /> You next

He initiated a question by causing an overlap in his conversation with SK as he did within the conversation with his wife, which is shown in the following part of the conversations:

SK: That's the Fin[ish ./>

RS: [Is that it ?/> You next (0.2)

SK: Ya ./

Summary

Though RS used the same FTT overlap strategies (requests and feedback), the main difference between the two conversations was found in the occurrence of FTTs. As mentioned earlier, AS behaved more resolutely than SK in terms of Words/Con. This behaviour was found in the percentage of FTT as well. Here, AS was "pushing" the conversation and an increased use of requestives was supposed to lead RS to a greater contribution to the conversation, but was resulting in a lower percentage number of FTT overlaps; lots of attempts to win a turn were overrun by AS.

Number of FaiTT

a. Percentages

Familiar condition

Nine FaiTT overlaps were initiated by RS. We calculated a percentage of 36% as a share of the number of Overlaps.

Unfamiliar condition

Under the UnF condition, RS Failed in Taking a Turn three times, which was a percentage of 30%.

b. Qualitative Analysis

Familiar condition

Except for one occasion, all FaiTTs were Confirmation overlaps which have been described above. The example below demonstrates an FaiTT overlap initiated with a Confirmation overlap. RS and his wife were discussing where to find the item "Flight Museum" on the map. RS interfered briefly with a confirming "Mhm" and gave the signal *You more*.

AS: Is it got aircraft there ((there: 114Hz-91Hz-105Hz)) ?/> You next (0.13)

RS: No ((80Hz-159Hz-132Hz)) / (0.92) ((drawing noise))

AS: Flight Museum / that' [s interesting ((interesting: 100Hz-214Hz)) (0.8)

RS: [Mhm /

AS: okay (0.33) /and the:n (0.16) I precede on pass the Disused Monastery which is really crumbling falling down and that's on my left ((left: 197Hz-219Hz-121Hz)) /> You next then Me further

One FaiTT overlap involved a repetition as an initiator for a possible question, stopped by RS due to AS's continuing speech and because she offered further information. The overlap is shown below.

After having difficulties finding the item "Disused Monastery" on his map, AS provided an alternative item ("Alpine Garden") for a correct orientation, which led to a request by RS about the location:

RS: Now I see what you mean you say you go (0.36) / and where is that / is it on your [right

AS: [That [that Alpine Garden is on my right ((right: 174Hz-114Hz)) /> You next (0.24)

RS: [That's wh-

Unfamiliar condition

RS initiated one FaiTT by using a Confirmation. He interrupted at a TCU and before a possible TRP:

SK: On the left hand side of the Cliffs / [as we look at them ((them: 121Hz-313Hz-238Hz)) /

RS: [Ya ./> You more

Two other FaiTT overlaps have been onset sounds initiated before an upcoming TRP:

SK: Oh no there is another set of Wheat [fields ((fields: 283Hz-309Hz)) /> You next (0.44)

RS: [((Onset sounds)) /

Summary

Comparing RS behaviour within the F and UnF conversation, he initiated far more overlaps out of a Confirmation overlap which resulted into an FaiTT in his conversation with AS than with SK as conversational partner. Clearly, RS relied on the well-known conversational behaviour of his wife and was able to assess that an initiated (completed, see below) feedback is sufficient in order to continue the conversation and to complete the task quickly.

Number of FaiTTC

a. Percentages

Familiar condition

RS initiated eight FaiTTC overlaps. We calculated a percentage of 32% of the number of Overlaps.

Unfamiliar condition

RS overlapped SK once, with a percentage of 10% of the number of Overlaps.

b. Qualitative Analysis

Familiar condition

The one FaiTT that was not marked as FaiTTC overlap was the example shown above:

RS: Now I see what you mean you say you go (0.36) / and where is that / is it on your [right
AS: [That
[that Alpine Garden is on my right ((right: 174Hz-114Hz)) /> You next (0.24)
RS: [That's wh-

All other FaiTT overlaps were identified as FaiTTC overlaps, no acoustic cues or context indicated any attempt to continue his speech.

Unfamiliar condition

The example given below shows the only FaiTT, also a Confirmations overlap, that was considered as completed:

SK: On the left hand side of the Cliffs / [as we look at them ((them: 121Hz-313Hz-238Hz)) /
RS: [Ya ./> You more

RS waited for SK to finish her turn and took the turn at a TCU.

Summary

Comparing the F and UnF percentages, we found that RS showed a higher percentage for the number of FaiTTC in the conversation with his wife leading to the assumption that he was more dominant regarding a completion of his utterance. However, as all FaiTTC overlaps were also labelled as Confirmations, we may have to reconsider and weaken this argument.

Number of Others

a. Percentages

Familiar condition

No overlaps of the category Others have been initiated by RS.

Unfamiliar condition

In the category Others, two overlaps were caused by RS. We calculated a percentage of 20% of the number of Overlaps.

b. Qualitative Analysis

Familiar condition

No Others overlaps have been made by RS.

Unfamiliar condition

Both overlaps evaluated as overlaps in the category Others were onset sound overlaps produced by RS. As they do not show any information about RS's intentions, no further comment on these occurrences can be made.

7.5.1 Discussion

Our bvFTD patient, RS, was slightly more involved in the conversation with the UnF partner (SK) regarding the number of Words/Conv%. The percentage for the number of Words/Conv differed by 3.33%. He also produced more Overlaps/Conv within this conversation (F = 2.48% and UnF: 2.76%). This observation was in agreement with his wife's statement about him interrupting current speech more often if he talks to strangers.

RS initiated more overlaps of the category Confirmations, Predictions, FaiTT and FaiTTC in the F condition than in the UnF condition. Only two categories (FTT and Others) showed greater percentages, compared to the number of Overlaps of RS, for the UnF condition.

It seemed that RS had increased timing difficulties within the conversation with his wife resulting in higher percentages for the number of Confirmations and Predictions. We assumed that the conversational behaviour of AS caused this outcome. It became clear that RS acted based on the Familiarity in terms of stopping or cancelling initiated turns more often, but also due to AS's dominant leading of the conversation in to an increased number of FaiTT overlaps.
SK's speech behaviour on the other hand was more cautious and reluctant resulting in an increased percentage for the number of FTT overlaps.
However, we found that, for the category FaiTTC, RS used short feedback overlaps more often in the conversation with his wife than with SK, possibly to demonstrate his staying in conversations and to respond to the frequently initiated requestives by AS.

We found greater difference (> 20%) between the F and UnF condition for the categories Confirmations (difference = 32%), FaiTTC (difference = 22%) and Others (difference = 20%).
The differences for the category Predictions (difference = 10%), FTT (6%) and FaiTT (difference = 6%) were relatively weak.

7.5.2 Behavioural-Variant Frontotemporal Dementia: Comparison of First, Second and Third Recording

RS was recorded the second time seven months after the first recording. Six months later, a third recording took place. The first two recordings sessions were recorded with his wife and an UnF partner. The third conversation was conducted only with his wife, but not with an unknown person, due to organisational difficulties.
In the following, we will present and evaluate the collected data.

<u>Questionnaire (November 2015):</u> RS's wife did not find any changes in behaviour or speech since the last recording.

<u>Subjective note (November 2015):</u> His wife reported that our bvFTD patient's character changed over the year into a more juvenile character. He became restless and had to walk all the time. According to his wife, he also showed repetitive speech behaviour in terms of telling a story more than one time.

<u>Data and percentages</u>
Table 133 summarises the number of Words/Conv(%) and the number of Overlaps(%) for the bvFTD patient for a time period of one year.

	bvFTD data I		bvFTD data II		bvFTD data III	
Total number of Words/Conv	F: 1010	UnF: 362	F: 365	UnF: 676	F: 462	UnF: --
Words/Conv(%)	237 (23.47%)	97 (26.8%)	106 (29.04%)	92 (13.61%)	51 (11.04%)	--
Total number of Overlaps	25 (34)	10 (19)	5 (6)	20 (24)	5 (6)	--
Overlaps/total number of Overlaps%	73.53%	52.63%	83.33%	83.33%	83.33%	--
Overlaps/Conv%	2.48%	2.76%	1.37%	2.96%	1.08%	--

Table 133 Number of Words/Conv(%), Overlaps/ total number of Overlaps% and Overlaps/Conv% (bvFTD I, bvFTD II and bvFTD III)

For the F condition, we found a decrease in the total number of Words/Conv, from 1010 to 462. Regarding the percentages for the F NL bvFTD speaker, RS, an overall decrease was found for the number of Words/Conv%, with a difference of 12.43%. However, RS showed a small increase from the first to the second recording.

For the number of Overlaps/total number of Overlaps% we found increased percentages for the second and third recordings.

We found a decrease in the percentages for the number of Overlaps/Conv%.

All in all we observed an overall decrease in the data from the first to the third recording for the total number of Words/Conv, number of Words/Conv% and the number of Overlaps/Conv%.

In the UnF condition, RS showed a decrease for the number of Words/Conv% from the first to the second recording and increased percentages for the number of Overlaps/total number% of Overlaps and the number of Overlaps/Conv%.

By comparing the progression of the F NL bvFTD and the UnF NL bvFTD percentages from the first to the second recording session, we only found an increase for the number of Overlaps/total number of Overlaps% for both, F NL bvFTD and UnF NL bvFTD. All other measurements did not match the progression process (e.g. number of Overlaps/Conv%: F NL bvFTD = decreased but UnF NL bvFTD increased).

Number of Confirmations

Comparing F and UnF data and their percentages, Table 134 shows that F NL bvFTD data and UnF NL bvFTD data increased.

Interestingly, RS remained relatively stable in terms of Confirmations% overlap for the first and second recording (difference = 8%) with his wife, but increased to 100% in the third conversation. In this third meeting, RS was highly restless in terms of moving and this may have been reflected in his conversational behaviour, too. He may have confirmed more frequently to speed up the speech flow. All overlaps were initiated shortly before a (possible) TRP came up, which would support this assumption.

Confirmations(%)	bvFTD data I	bvFTD data II	bvFTD data III
F NL bvFTD	18 (72%)	4 (80%)	5 (100%)
UnF NL bvFTD	4 (40%)	16 (80%)	--

Table 134 Number of Confirmations. Percentages are shown in parenthesis (bvFTD I, bvFTD II and bvFTD III)

Number of Predictions

The number of Predictions% dropped for RS from the first to the second recording, but increased for the third recording up to 80% during the conversation with his wife (Table 135).
The UnF NL bvFTD data increased the number of Predictions%.
By considering the high outcome in the category Predictions% for the F condition, it seemed that RS was able to predict (possible) TRPs and initiated overlaps accordingly over the 12 months. However, the type of response following a Predictions overlap changed: he predicted an upcoming TRP and continued his turn with a complete utterance more often in the first conversation. He still predicted TRPs in the second and third recording, but only to continue with a short reply (mainly Confirmations).
In order to predict intentional behaviour, interlocutors interpret each others behaviours which are caused by beliefs, hopes and wishes (Levelt, 1999). Premack and Woodruff (1978) named this interpretation ability the Theory of Mind (ToM). Levelt (1999) noted that the ToM allows conversational partners to build up complex structures of knowledge about social attitudes.

It may have become difficult for RS to interpret the intention of his partners and to predict the grammatical structures as well. In particular, the difference between the second and third recording supported this assumption as we found an increase of 40% in the category Predictions for the F condition. His aim may have been to cover up his cognitive limitations by using simple structured sentences/utterances initiated as Predictions.

Predictions	bvFTD data I	bvFTD data II	bvFTD data III
F NL bvFTD	15 (60%)	2 (40%)	4 (80%)
UnF NL bvFTD	5 (50%)	14 (70%)	--

Table 135 Number of Predictions. Percentages are shown in parenthesis (bvFTD I, bvFTD II and bvFTD III)

Number of FTT

Table 136 summarises the FTT(%) results for the F and UnF condition. The data of RS for the F and UnF condition increased in percentage over time.

The second and third recording revealed the same percentages for the F NL bvFTD data for the number of FTT%.

The UnF NL bvFTD data showed a small increase in the percentages of only 5%. Comparing the difference between the first and second recording under the F condition, a stronger difference was found, with 16%.

For the category FTT, it seemed that Familiarity had a great impact on RS' conversational behaviour. AS (F L bvFTD) seemed to behave more cautiously and reluctantly in her conversational behaviour and allowed her husband to Take his initiated Turns Fully more often during the later stage of the disease. RS' changed behaviour in personality may have influenced this category as well. He was more outgoing and showed an increased confidence that may have resulted in an increased use of FTT overlaps, too.

FTT	bvFTD data I	bvFTD data II	bvFTD data III
F NL bvFTD	16 (64%)	4 (80%)	4 (80%)
UnF NL bvFTD	7 (70%)	15 (75%)	--

Table 136 Number of FTT. Percentages are shown in parenthesis (bvFTD I, bvFTD II and bvFTD III)

Number of FaiTT

The F NL bvFTD percentages for the number of FaiTT overlaps decreased from 36% to 20%, from the first to the second/third recording. The second and third recording showed no difference in their percentage. The UnF NL bvFTD data decreased with only 5% from the first recording result to the second one (Table 137).

The F NL bvFTD data indicated that RS was more successful in Taking Turns Fully rather than losing an initiated overlap. This observation was supported by the increase in the percentages for the number of FTT (reported above.)

In the UnF condition, the difference between the percent data was small, showing that the conversational behaviour with a stranger did not differ over time.

FaiTT	bvFTD data I	bvFTD data II	bvFTD data III
F NL bvFTD	9 (36%)	1 (20%)	1 (20%)
UnF NL bvFTD	3 (30%)	5 (25%)	--

Table 137 Number of FaiTT. Percentages are shown in parenthesis (bvFTD I, bvFTD II and bvFTD III)

Number of FaiTTC

In the F condition, RS initiated FaiTTC% overlaps less often over the progress of the disease. The difference in the percentages was 12%, whereby the percentages for the second and third recording were 20%.

The UnF NL bvFTD data showed an increase of 5% as it is displayed in Table 138.

The decrease in F NL bvFTD percentages may indicate that the RS was less involved and less motivated to initiate FaiTTC overlaps. This expectation was supported through the reduced number of Words/Conv% for the third recording, but also through his increased percentages for the category FTT. If RS attempted to take the floor, he did so successfully in the conversation with AS.

All FaiTTC overlaps, except for one, were also labelled as Confirmations. This finding also shows that RS strongly reduced the number of short utterances and phrases he produced over time.

The one FaiTTC overlap that is not marked as Confirmation overlap is shown below and taken from the second UnF conversation with KL and RS.

RS: What's a Springbok ((springbok: 144Hz-124Hz-137Hz)) ?/> You next (0.79)
KL: A:h so they may not be say / maybe the [re aren't any /
RS: [I think these are same thing ./
KL: <e:> / they might be different /
s [o:
RS: [I think it's different ((different: 187Hz-105Hz-190Hz)) /

This example has been marked as FaiTTC, because RS did not intend to continue his speech in the first place. He echoed KL, which was judged as a different turn.

FaiTTC	bvFTD data I	bvFTD data II	bvFTD data III
F NL bvFTD	8 (32%)	1 (20%)	1 (20%)
UnF NL bvFTD	1 (10%)	3 (15%)	--

Table 138 Number of FaiTTC. Percentages are shown in parenthesis (bvFTD I, bvFTD II and bvFTD III)

Number of Others

Both overlaps, which have been initiated by RS in the UnF conversation at the first recording session, were onset sounds. The fact that no Others overlaps have been initiated, e.g. laughs or editing terms, may be due to RS' changed conversational behaviour and personality. From the beginning on, he was very deliberate and focussed in completing the speech task compared to other subjects, especially with his wife.

Others	bvFTD data I	bvFTD data II	bvFTD data III
F NL bvFTD	0 (0%)	0 (0%)	0 (0%)
UnF NL bvFTD	2 (20%)	0 (0%)	--

Table 139 Number of Others. Percentages are shown in parenthesis (bvFTD I, bvFTD II and bvFTD III)

7.5.3 Conclusion

By comparing the first and second recordings for the F and UnF percentages, we found, for both conditions, an increase in the percentages for the number of Overlaps/total number of Overlaps% and the categories Confirmations and FTT. We observed a decrease for both, F NL bvFTD and UnF NL bvFTD percentages for the category FaiTT.

In the UnF condition, RS showed an increased use of Overlaps/Conv% as well as a higher number of Overlaps/total number of Overlaps%. However, his involvement in the conversation was reduced as the percentage for the number of Words/Conv% revealed (difference = 13.19%).

A greater difference (> 10%) between the first and second recording in the UnF condition was found for the number of Overlaps/total number of Overlaps (difference = 30.7%), Confirmations% (difference = 40%), Predictions% (difference = 20%) and Others% (difference = 20%).

For the categories in the UnF condition, we found an increase in the percentages for the number of Confirmations%, Predictions%, FTT% and FaiTTC%. A decrease of the percentages was found for the category FaiTT and Others.

In the UnF condition, RS mainly increased his initiation of overlaps of the categories Confirmations and Predictions. This conversational and overlap behaviour may indicate RS' strategy to stay in the conversation. Simple structured phrases, such as feedback utterances, were easily to recall for RS and highly routinized in his speech repertoire. RS initiated Predictions overlaps once he was sure that a TRP would come up, especially in the second recording. He seemed to increase this behaviour in order to strengthen the impression of being part of the conversation.

We will compare the first and third recording for an interpretation of the F NL results of RS.
In the F condition, we found a decrease in percentage for the number of Words/Conv%, Overlaps/Conv%, FaiTT% and FaiTTC%.
An increase in percentage over time was found for the number of Overlaps/total number of Overlaps%, Confirmations%, Predictions% and FTT%.

In general, RS was less involved in the conversation and showed a reduced number of Words/Conv (difference = 12.43%). He decreased accordingly the percentage for the number of Overlaps/Conv% as well.

However, RS increased the use of overlaps of the categories Confirmations (difference = 28%), Predictions (difference = 20%) and FTT (difference = 16%). Almost all overlaps of the categories Predictions and FTT were short feedback utterances. Again, RS seemed to use simple and highly routinized phrases in order to strengthen the impression of him being part of the conversation though he may not have been able to follow the instructions or the conversation.
The decrease of the percentage in the categories FaiTT and FaiTTC may have been due to the changed conversational behaviour of his wife. As it was difficult to keep RS interested in the conversation and to motivate him to being part of it, she was more willing to step back and accept overlaps more often in order to reinforce RS' contribution.

Chapter 11 Conclusion and Future Work

Profiling dementia is an urgent need as we outlined throughout and especially in Chapters 1 and 2. According to the Alzheimer's Society only 48% of people with dementia are diagnosed; "there are still around 416,000 people in England who are living with dementia but who are not diagnosed"[5]. As mentioned by Jones et al. (2016) the "diagnostic process requires considerable expertise, is costly and time-consuming and cannot be offered to all people complaining of memory problems" (Jones et al., 2016), p.2). Interactional features, used collectively "have the potential to enable differential diagnosis based on communicative practices" (Jones et al., 2016), p.7). As we intended to improve the success rate of an early and correct diagnosis of dementia, we therefore applied this concept on to speech in dementia and its subtypes.
The overall aim of this work was to find a powerful methodology, based on speech analysis, able to differentiate subtypes of dementia at an early stage of the disease in order to develop an application for a differential diagnosis of Alzheimer's disease (AD) and frontotemporal dementia (FTD), with its subgroups (semantic dementia (SD), progressive non-fluent aphasia (PNFA) and behavioural-variant frontotemporal dementia (bvFTD).

Table 140 displays acronyms used in this work at a glance:

Acronym	Term
L	Lead
NL	Non-Lead
F	Familiar
UnF	UnFamiliar
AD	Alzheimer's Disease
FTD	FrontoTemporal Dementia
bvFTD	Behavioural-Variant FrontoTemporal Dementia
PNFA	Progressive Non-Fluent Aphasia
SD	Semantic Dementia

Table 140 Acronyms of terms

The method of choice for our analysis is a part of Conversation Analysis (CA) which focuses on meaning and the constructive function of speech by detailing its interactional processes (Avdi, 2008) (Chapter 3). The concept of CA is to analyse the whole construct of communication rather

[5] https://www.alzheimers.org.uk/site/scripts/documents_info.php?documentID=2165

than utterances and sentences in isolation. The ability of a conversation participant to analyse past speech events in order to predict the upcoming event carries the continuity of the talk.
As we hypothesised in the beginning that dementia patients overlap in conversations more often than healthy subjects, we wished to explore speech in dementia and we were interested in whether the types and number of Overlaps occurring in conversations including patients suffering from AD and FTD (PNFA, SD and bvFTD) could be characterised and differentiated from healthy speech or not.
We categorised overlaps according to definitions as suggested by the literature but also customised these in order to fit and meet dementia speech' characteristics. Our categories are namely: Confirmations, Predictions, Full Turn-Taking (FTT), Failed Turn-Taking (FaiTT), Failed Turn-Taking Completed (FaiTTC) and Others. Table 141 displays the acronyms of the categories FTT, FaiTT and FaiTTC.

Acronym	Category
FTT	Full Turn-Taking
FaiTT	Failed Turn-Taking
FaiTTC	Failed Turn-Taking Completed

Table 141 Acronyms of categories

Our approach of applying quantitative categories or measurements on to qualitative conversational data in order to differentiate healthy and dementia speech is new and directly addresses the objection of Schegloff (1993) that quantitative measurement of talking and of units of speech may result in a loss of meaning. We countered his objection by using proportions in preference to number of Overlaps per conversation rather than by restricting the analysis to a certain number of words or by using time as denominator, which was considered by Schegloff (1993) as an interactional meaningless unit. We outlined in Chapter 5.4 that qualitative methods are critically reviewed due to the "lack […] for bridging or translating between the worlds of qualitative and quantitative research" ((Boyatzis, 1998), p.vi). Therefore, we combined qualitative and quantitative analyses to ensure a substantial evaluation, based on the logic of the so-called "triangulation" which has "the premise that no single method ever adequately solves the problem of rival explanations. Because each method reveals different aspects of empirical reality, multiple methods of data collection and analysis provide more grist for the research mil." ((Patton, 1999), p. 1205).
For this approach, we undertook a study of healthy controls (healthy study) in which we analysed 24 recordings and a patient study for which we recorded 27 conversations including dementia patients as conversational partners. We analysed the recorded conversations in terms of overlaps,

according to the six categories as outlined in Chapter 5.3. We compared the conversational behaviour statistically between healthy-healthy pairs and healthy-AD pairs. Further, we made a case study analysis of each of the FTD subtypes. For a small sample of subjects who we were able to record more than once over the duration of the study, we performed a longitudinal analysis.

One novelty of this work was the implementation of the non-invasive procedure of CA and another one the approach of quantifying qualitative measurements in order to diagnose subtypes of dementia. The analysis of overlapping talk seems promising and by considering the results presented in this study easily practicable. The triangulation of our data and the direct addressing of Schegloff (1993)'s criticism by using the above-described methodology is an innovative approach in dementia research and could be applied more generally to CA in clinical populations as it provides insights about planning of speech and strategic behaviour in conversations.
The map task we used to elicit conversation supports our methodology; we were able to collect to a certain extent spontaneous speech data without constraining the conversation to only one specific feature occurring in interaction (Anderson et al., 1991). We did have some guidance as a result of the map tasks' experimental design (lead vs. non-lead). However, the map task's approach is to "form […] a corpus of dialogues large enough and controlled enough to permit profitable simultaneous study from a number of points of view. While the dialogues in the corpus are unscripted, the corpus as a whole comprises a large, carefully controlled elicitation exercise" ((Anderson et al., 1991), p. 352).

As one of the incorporated variables of the design is Familiarity of participants, we implemented this controllable feature as a novelty regarding analysing speech in dementia developed in and emerging from this study. We wished to investigate a Familiarity effect and by conducting the map task, we were able to identify the effect for some categories. We were even able to differentiate healthy and AD speech and to characterise the FTD subgroups in this respect. Our finding suggests that persons not well-known to a patient, e.g. practitioners and clinicians, should keep in mind that patients may organise their speech differently when talking to strangers.

By using the map task and our analysis approach, we provided an additional tool to emphasise a distinct diagnosis of dementia and its subgroups. As we outline in Chapter 11.1, a larger cohort will be needed in order to confirm our findings.

<u>Summary of research findings referring to our initial research questions</u>

In the beginning of the study, we wanted to investigate the differences in conversations between two healthy people and between a healthy person and a person with dementia.

1. We wished to investigate whether the different types of dementia can be characterised by their speech behaviour in conversations or not.

For this purpose, we chose the map task as experimental design to elicit spontaneous speech data and defined six categories in order to code the different types of overlaps in speech as we derived evidence from the literature that a decline of working memory or slower progression of discourse may result in an increased number of Overlaps.

We found promising results which characterised healthy speech regarding overlapping in conversations. The statistical analysis showed that the categories Confirmations and FTT revealed high values for the number of Overlaps (Confirmations: 40% and FTT: 60%), implying that constant feedback throughout Confirmations was used as a large contribution to the conversations and led frequently to successful turn-takings and the capacity to plan and execute turn-taking whilst processing the other person's input is very distinct.

We continued by analysing our AD speech data, to see if there were differences in the number of Overlaps/Category%. The distribution of data revealed the highest value of Overlaps of the total number of Overlaps in the categories FTT (56%), with Confirmations at 38% and the lowest number in the category Others (12%).

We were able to calculate differences in the categories for healthy and AD speech, and we compared NL H and NL AD data and we were able to find measurable differences for the categories FTT (4.32%) and Confirmations (3.23%). We calculated the Common Language (CL) effect size for each category and showed a small effect for FTT (CL = 0.56), FaiTTC (CL = 0.56) and Others (CL = 0.59), implying that these categories differentiate both groups measurably.

The overall data for our FTD patients revealed high values for the categories FTT (65%), Confirmations (41%) and FaiTT (35%).

Though we found a similar distribution of categorical data between healthy and AD, we showed that the values for each category differed between H and AD data and were able to describe H, AD and FTD speech by using our categories.

We characterised and differentiated H and AD speakers' conversational behaviour quantitatively by using the map task and by categorising the different types of overlaps.

2. We wished to find evidence for a change in speech with disease progression by analysing overlapping in conversations.

For the AD data, we were only able to compare two F NL AD speakers, but we found that they both declined in numbers for the category Others and increased in numbers for the category Predictions.

For the PNFA patient (F condition), we found increased percentages from the first to the second recording for two categories: Confirmations (difference = 8.93%) and FTT (difference = 7.14%). Over a period of 13 months, we found for the bvFTD patient a decrease in the number of Overlaps during his interaction with a familiar person for the categories FaiTT and FaiTTC. All other categories showed an increase in values. The patient seemed to use simple and highly routinized phrases in order to strengthen the impression of him being part of the conversation though he may not have been able to follow the instructions or the conversation.

By using the map task and the six categories, we were able to find some evidence for a change in dementia speech for the AD data, but also tendencies for a change in the PNFA and bvFTD data (the SD patient was not recorded a second time). Due to our small samples this aspect needs further exploration in a future study in order to confirm and expand our findings..

3. We wished to determine whether there was a Familiarity effect in conversations including two healthy subjects and conversations including one AD/FTD patient.

For the H data, we showed a Familiarity effect for the categories Predictions, FTT, FaiTT, FaiTTC and Others by calculating the effect size.

For the AD speech data, we found a Familiarity effect by calculating effect sizes for the categories Confirmations, FTT, FaiTT, FaiTTC and Others. We were not able to show a Familiarity effect for the category Predictions.

We found tendencies towards a Familiarity effect throughout the analysis of the overall FTD data of three patients, but a larger cohort would be needed to validate the results.

These findings may have implications for the design of protocols for gathering reliable diagnostic or monitoring data. Professionals do have to keep in mind that dementia patients may overlap with a different frequency or may dominate their turn-taking behaviour with a certain category type of overlaps in their interactions differently to what healthy people would do.

In the following sections, we will refer back to our research proposals and questions in more detail to support the findings above.

Healthy Study

In this section, we will first demonstrate in summary the suitability of the selected overlap categories for analysing the conversations followed by our findings regarding a Familiarity effect, supporting in more detail the overview given above.

Key findings

- We found examples of overlaps for all categories in healthy conversation
- Measurable characteristics for the six categories were found in the number of Overlaps for the healthy speakers (e.g. FTT and FaiTT)
- By using inferential statistics and calculating the Common Language (CL) effect size, we confirmed a small Familiarity effect
- UnF NL H speakers showed higher values for the number of Overlaps than F NL H speakers

<u>Suitability of the categories to measure categorical differences</u>

In order to validate our experimental design, using the map task, we started by measuring the occurrence of the categorical differences in order to see if they were commonly present in conversation.

We found examples of all our defined overlap categories in the healthy conversations demonstrating that the map task is able to elicit these kinds of behaviours in healthy speech.

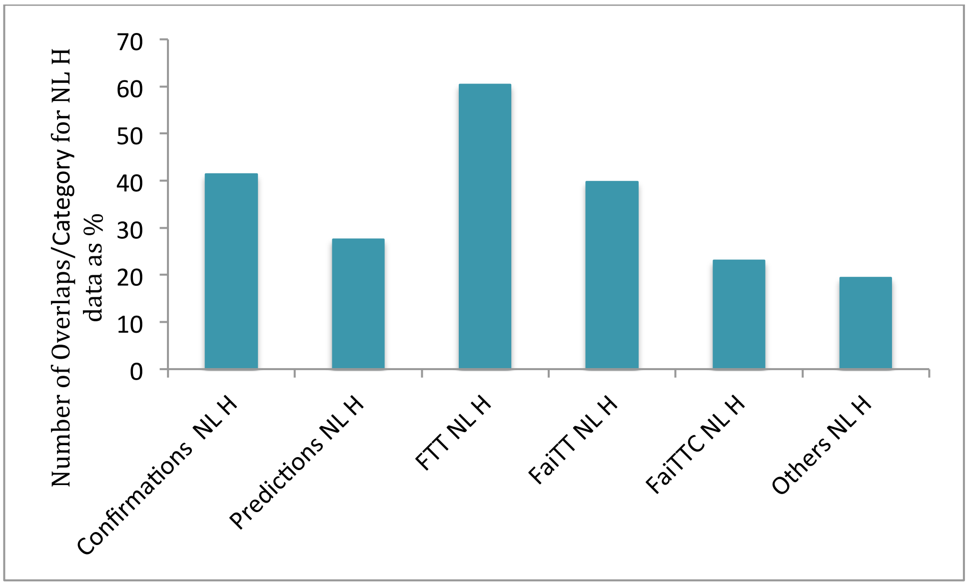

Figure 6 Number of Overlaps/Category for NL H data as %

Since we found a measurable difference of 20% between the percentage of Full and Failed Turn-Takings (Figure 6), we conclude that these categories may be particularly useful measures and differentiate the distinct conversational behaviour of our NL H subjects regarding the number of Overlaps.

In general, the distribution of FTT vs. FaiTT overlaps shows how healthy speakers organise their interaction with their partners; how often they withdraw and how often they complete their initiated turn-taking during current speech. This behaviour allows conclusions about involvement

and speech flow influenced e.g. by politeness, insecurity about task performance and/or by a supportive attitude. We outlined possible conclusions in detail in Chapter 7.2.
Since we expect a different distribution in terms of numbers of Overlaps for these categories in the AD group (Chapter 6), we consider the FTT and FaiTT (and as a consequence FaiTTC as well) measurements as likely to be useful regarding the characterisation of both healthy and AD speech.
We were able to measure the distribution of categorical data with regard to types of overlap in healthy subjects and the differences in percentages between the categories.
We were able to show the map task could be used in order to elicit samples of spontaneous speech as well as to confirm the suitability of our chosen parameters to analyse speech with respect to overlaps.

We defined the category Others quite broadly as we wanted to consider all overlaps not fitting in to the other categories instead of leaving them out. Taking Others overlaps into account revealed that the categories Confirmations and Predictions formed the major part of overlaps and that the differentiation of laughs and editing terms etc. could reasonably be neglected for healthy subjects. However, we think it may be fruitful to look into this category in more detail for further investigation. An observation of significantly higher values for editing terms rather than for laughs or pauses or vice versa may lead to further conclusions about appropriateness (e.g. expressed by a high number of laughs) or discourse limitations (e.g. expressed by a high number of hesitations).

Besides a more detailed look in to the overlaps in the category Others, we also suggest to redefine the category Predictions. For this study, we concatenated the prediction of

1. upcoming TCU or possible TRP's by analysing the currently used grammatical and intonational structure with
2. the prediction of "what will be said" in terms of predicting for example (already) mentioned items verbally or written on the map.

A further differentiation within the category Predictions may provide additional details of overlapping behaviour in conversations. If a separation took place, we would be able to evaluate the different emphasis of
1. limitations of grammatical abilities and
2. discourse comprehension with regard to a characterisation of dementia speech.

Familiarity effect

In order to address research question 3, we evaluated the healthy data regarding a possible Familiarity effect. The results will be summarised in this section.

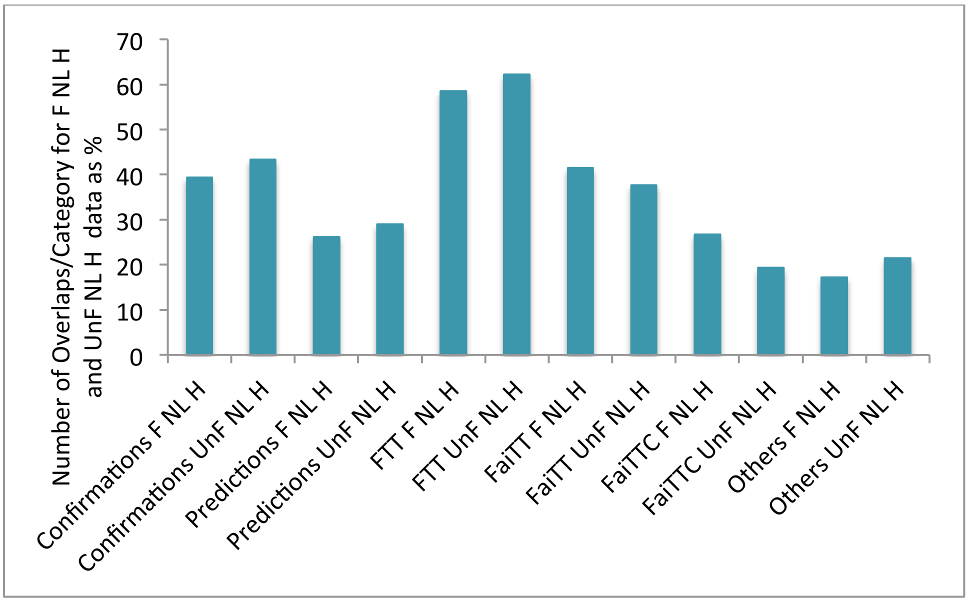

Figure 7 Number of Overlaps/Category for F NL H and UnF NL H data as %

Regarding a possible Familiarity effect we found differences between F NL H and UnF NL H behaviour in several different categories: in the number of Predictions%, FTT%, FaiTT%, FaiTTC% and Others% a small to medium effect between F NL H and UnF NL H was observed (Figure 7). We suggested in Chapter 2.4 that an over simplification of parameters or the experimental design may have caused the lack of finding a Familiarity effect in the existing literature. As we were interested to explore a Familiarity effect in overlap behaviour rather than in other discourse features, we compared literature findings favouring a Familiarity effect by investigating overlaps with our results: As we outlined earlier, Bortfeld et al. (2001) and Yuan et al. (2007) found statistically significant differences for the number of Overlaps between F and UnF data and therefore evidence for a Familiarity effect in their corpora.

In our study, the mean percentage for the overlap ratio (total number of Overlaps/total number of Words) for the F H group was 3.47% and for the UnF H speakers 3.78% (CL = 0.58, small effect) which is in agreement with Bortfeld et al. (2001). We have used a similar design to Bortfeld et al. (2001), and our findings regarding the distribution of F and UnF data were also similar.

With our data, we confirmed a small Familiarity effect using inferential statistics and the CL effect size. We think that a larger cohort could strengthen the results and give clearer tendencies favouring one condition or the other. We assume that the UnF H data will probably be favoured over the F H data as we expect that people who know each other will better perform in coordinating their interaction (Bortfeld et al., 2001).

AD patients

Following the healthy study and supported by the evidence that the experimental design could elicit overlap behaviour with our categories, we continued by initiating a patient study to explore the characterisation of AD speech.

We analysed AD speech only, as we were not able to collect data from an adequate number of SD, PNFA and bvFTD patients. Therefore, we decided to report case studies on the FTD data later on.

Key findings

- We found examples of overlaps for all categories in AD conversation
- The categories Confirmations and Predictions are considered as good representatives for a distinct conversational behaviour regarding overlapping
- The categories FTT and FaiTT characterise the organisation of speech in AD well
- Except for the category Predictions, we found a Familiarity effect for all categories

Suitability of the categories to measure categorical differences

We found examples of all categories in the AD conversations demonstrating the suitability of our task to elicit overlaps in our defined categories and suggesting they were promising in order to characterise AD speech (Figure 8).

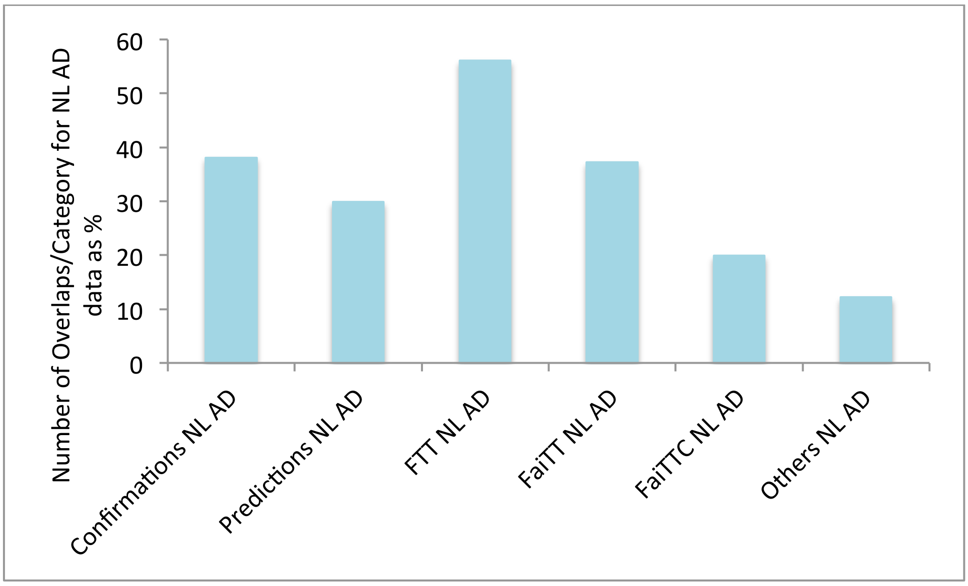

Figure 8 Number of Overlaps/Category for NL AD data as %

Confirmations overlaps are a frequently used feature in order to complete the map task efficiently and were characteristic of AD speech. We further showed that as well as Confirmations during conversations, the predictive ability of current speech is a suitable, but less used conversation technique in order to finish the task in AD speech.

The lower occurrence of Others overlaps in AD speech suggested that the categories Confirmations and Predictions were good representatives for a predominant conversational behaviour regarding turn-taking.

We found a great difference in percent between Full and Failed Turn-Takings, suggesting that these categories are good measures in order to characterise and differentiate the conversational behaviour regarding the organisation and execution of planned overlaps of our AD NL subjects. As we found measurable differences in the percentages for our categories, we described AD speech regarding the ability of planning and executing intentions (Confirmations and Predictions) and showed that the strategic conversational behaviour is in favour of Taking the Turn Fully rather than withdraw from an initiated turn-taking.

Familiarity effect

As for the healthy study, we looked for a Familiarity effect in AD speech (Figure 9).

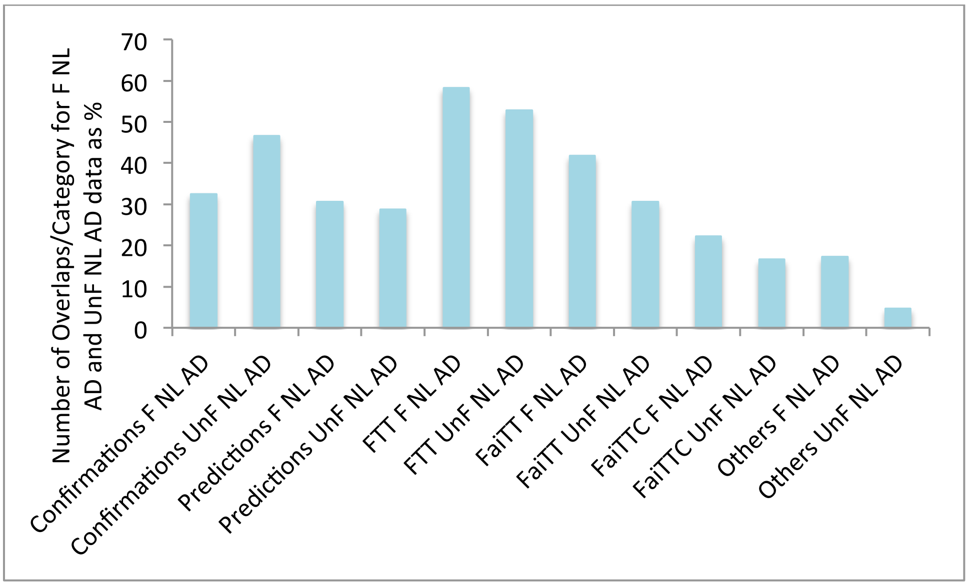

Figure 9 Number of Overlaps/Category for F NL AD and UnF NL AD data as %

We drew the following conclusions considering a Familiarity effect:

The simpler the structure of an utterance, the shorter the simultaneous processing of input and the intention to overlap in order to take the turn. To investigate this statement, we introduced the category Confirmations. The deficit of planning and execution of more complex speech which involves the ability to interpret the other person's intention and syntactical structuring, might have resulted in an increased use of feedback in the UnF condition as the patients tended to participate more in a conversation with a stranger. As we know from the literature (Ripich et al., 1991), AD speakers are aware of their conversational deficits and they may have increased their use of simple feedback overlaps to hide their limitations.

The attention ability, being expressed in predicting upcoming TRPs and following the syntactical structure in order to continue the current speech before it is completed, might have been limited in the AD subjects' speech processing in general (Guinn and Habash, 2012).
We conclude that there is a stronger confidence in the patients that the partner will accept an initiated FTT more readily than an UnF partner who is not familiar with the AD patient's language and conversational behaviour.
Based on our FaiTT results, we support the conclusion of Ripich et al. (1991) that AD patient's understanding of their own confusion and their knowledge of their familiar partner's interest of avoiding a conversational break-down, is more likely to contribute to the efficiency of the conversation by completing the task in less time by withdrawing from their initiated turn-taking. Moreover, it seemed that our NL AD speakers were more confident in finishing their turns, though they did not take the turn fully, with a familiar partner.
Our data revealed a higher number of Others% for the F NL AD subjects than for the UnF NL AD subjects. We did not interpret this outcome as we defined this overlap category quite broadly.

Analysing a Familiarity effect by using different types of overlaps is a new approach for evaluating speech in dementia and we found that a Familiarity effect may be deduced from a small/medium/large CL and from the statistical results observed in our study. Therefore we confirm the presence of a Familiarity effect in our data for each overlap category, except for the category Predictions. The size of the effect was, however, variable between overlap categories, with the smallest CL for the categories FTT (CL = 0.56) and FaiTTC (CL = 0.6) and the largest CL for the category Others (CL = 0.74).

<u>F NL AD data - Progression First and Second Recording</u>

We wished to explore a change in speech in dementia. Therefore, we analysed and evaluated AD conversations from a follow up session and compared the first and second recordings regarding overlapping.

Key findings

- F NL AD patients were less involved in the conversation (reduced number of Words/Conv)
- The ability to predict is still preserved, but the number of Overlaps in the category Predictions is increased
- We found a decrease in the number of Overlaps for the category Others

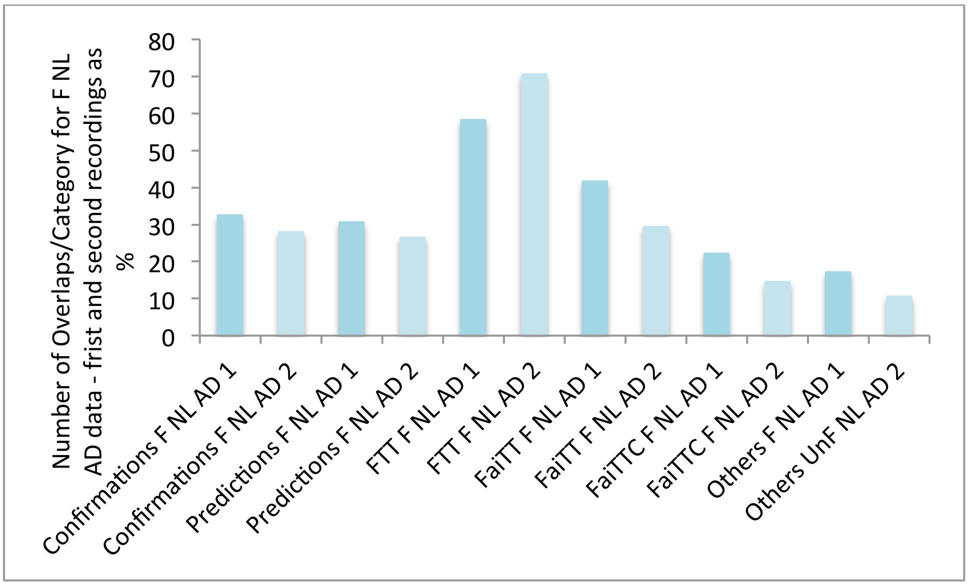

Figure 10 Number of Overlaps/Category for F NL AD data - first and second recordings - as %

We were only able to obtain a second recording for two of our AD speakers. Since we observed differences in our comparison of first and second recording for these two speakers under the F condition (Figure 10), we suggest that analysis of a larger cohort is needed for further defining speech behaviours that could be used to monitor progression of early-stage AD.

The monthly difference between the first and second recording sessions was five and eight months. For greater reliability, the recording sessions should take place in a *n*-monthly cycle. We planned to record every six months but due to time constraints and lack of participants, we were not able to meet our target. However, as the second recordings differ only by 3 months, we assume that the likely difference in disease progression is not likely to have a strong effect on conversation behaviour.

There are three developments in the occurrence of the number of Overlaps which we might expect in a larger cohort (> 12 participants (Guest et al., 2006)); either a strengthening of the difference for each category, a different distribution for each category or a balance of data with no difference. We know from the literature that the progression of dementia comes with a decline in language, therefore we expect a change in planning and execution of speech. Depending on the degree, we would expect at a later stage of the progression, a decline for the numbers of overlaps as mutism is a late-appearing feature in AD (Appell et al., 1982).

In this study, we focussed on those categories showing a similar direction of change (increase: Predictions/decrease: Others) for both speakers. For these categories we may expect a strengthened difference (Predictions and Others) when a larger cohort is evaluated.

In more detail, we found a decrease in the percentage for the number of Words/Conv and Overlaps/Conv suggesting that a study of this parameter with greater numbers of subjects might be revealing of behaviour changes related to disease progression.
Our observations showed that the ability to predict might still be preserved as AD progresses, and that it is likely to be used as a tool to be an active part of a conversation. The type of Predictions may change in number though. Patients may overlap more often if they detect and recognise the grammatical and intonational structure of e.g. questions, and may initiate their turn-taking earlier in order to stay in conversations. As conversational partners adjust their speech behaviour according to the skills of the dementia patient, it becomes easier for the AD patient to predict phrases and structures which results in an increased number of Predictions.
This observation is worthy of further investigation but would also need to include and consider the partner's conversational behaviour. Though we did have the data for the partners' speech, an analysis of their behaviour was beyond the scope of this present study.

AD and H subjects

In comparing the AD and Healthy subjects, we aimed to identify differences between these two speaker groups in order to demonstrate that our categories were able to characterise and differentiate H and AD subjects for each overlap category. The conjecture was that not well-known persons, such as clinicians or neurologists, will be able to detect specific attributes of AD speech regarding the different types of overlaps, as defined in this study. Contrasting with H speech was necessary to profile AD speech with the goal of developing a potential application to clinical assessments and disease diagnosis.

Key findings

- We found a **significant difference** in the means% of the number of Overlaps/Conv between the NL P (NL AD and NL FTD) and NL H speakers as well as for the UnF NL P and UnF NL H data
- The greatest difference between the NL AD and NL H data was found for the category Confirmations, where NL H showed a higher value than the NL AD speakers
- A full performance of turn-taking may be limited as we found lower values for the NL AD data than for the NL H group for the categories FTT and FaiTTC
- There was no indication that the F NL AD speakers were more willing to take a risk in terms of overlapping than the F NL H subjects
- The UnF NL H speakers revealed higher values in the categories than UnF NL AD speakers indicating that UnF NL H subjects perhaps used more features according to the categories

Comparing AD and H speech: suitability of the categories to measure categorical differences

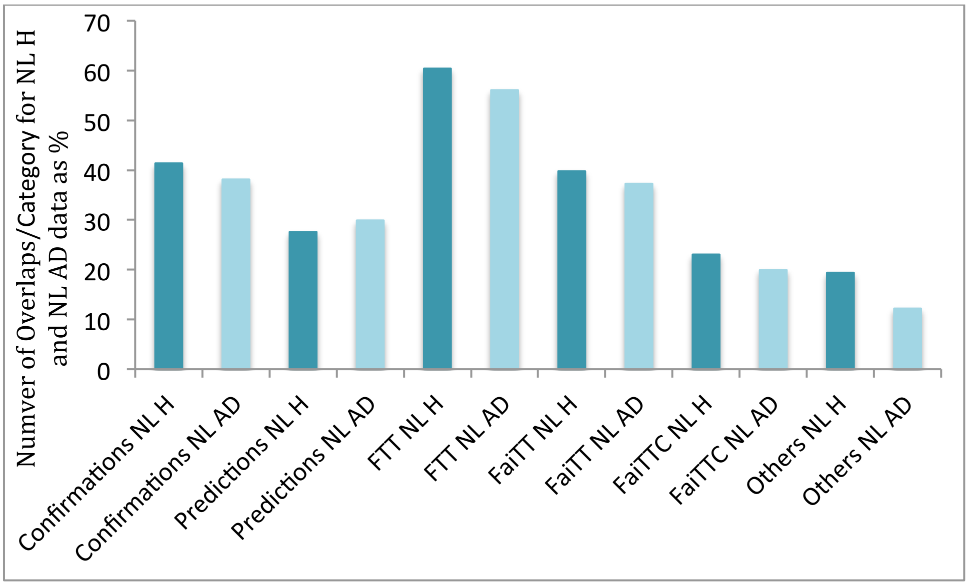

Figure 11 Number of Overlaps/Category for H and AD data as %

Comparing NL AD and NL H percentages, and considering the categories Confirmations and Predictions as giving information about the ability of planning and executing an intended overlap with the aim of taking the turn, we found the greatest difference for the category Confirmations. We found higher percentages for the NL H speakers than for the NL AD speakers regarding Confirmations overlaps (Figure 11). Further, our data showed that the ability to predict is still preserved in AD speech.

The strategic and intentional behaviour during the conversations revealed that NL AD subjects were less successful in taking the floor fully. The same observation was made for the category FaiTTC. The NL H speaker were able to Complete their initiated Turn-Taking more often than NL AD subjects. Based on the research of Dijkstra and Bourgeois (2004) about maintaining topics and cohesion and their finding that AD speech is abortive, we suggested that due to problems of poor concentration and a reduced ability to maintain concentration in AD speakers, a full performance of a turn-taking may be limited, leading to a decreased number for our AD subjects.

Laughs or editing terms, but also not understandable words (due to poor articulation in AD speech) seemed to be measurable for each group. In the future, this category should be analysed and defined in more detail as it is a promising category for characterising AD and H speech.

Comparing the suitability of the categories to measure categorical differences (F vs. F, UnF vs. UnF)

Based on our findings, we conclude that there is evidence for a measurable difference between NL H and NL AD speakers in our study. A characterisation of certain behaviour in conversations in terms of numbers of Overlaps and their distribution for each category was noticeable and distinct, especially if NL AD and NL H data in the F condition were compared (see next section). Parameters regarding planning as well as executing an intended overlap showed different tendencies for H and AD data (Confirmations = higher value for NL H subjects than for NL AD speakers, Predictions = higher value for NL AD than for NL H speakers).

Comparing the NL H and NL AD speech under the F and UnF condition

As we found a Familiarity effect for both, healthy and AD subjects, we continued by comparing the two groups for each condition in order to show probable differences.

Based on the statistical data and the CL (CL = 0.6; small sized effect), we found an effect for the category Confirmations where it was evident in the F condition that overlapping behaviour might be referable to the AD patients' lowered ability to contribute to spontaneous speech and their limited concentration and attention systems (Orange et al., 1998).

As familiar partners tend to ease conversations with dementia patients (Dijkstra and Bourgeois, 2004), an oversupply of possible TRPs may have increased the percentages in the category Predictions for the F NL AD subjects. Further, it may be that F NL AD speakers' partners were more demanding in terms of expecting participation, whilst the F NL H participants relied on the usual equal participation in the conversation (Sabat, 1991).
On the other hand, the UnF NL AD speakers' ability to predict an upcoming or possible TRP seemed to be preserved.

For the category FTT, we assumed that the difference was due to stronger confidence by the F NL AD speakers that the F L AD partner would accept an initiated FTT more readily than an F L H partner whose aim was to complete the speech task as efficiently (fast) as possible. The F NL H speakers were probably more reserved towards their partners than the F NL AD subjects and therefore decreased the percentage for the number of FTT (Sabat, 1991; Sacks et al., 1974).
The tendency of the UnF NL H subjects to be greater initiators of FTT overlaps, may show a greater need to influence the conversation and to take the floor more often (Taler and Phillips, 2008). The awareness of their own conversational difficulties may have stopped the AD speakers from initiating an overlap that could lead to a FTT overlap (Illes, 1989; Ripich et al., 1991).

The small CL effect size in the category FaiTT favoured the F NL H speakers over the F NL AD subjects regarding their percentage of initiated Overlaps. This outcome may be interpreted as a greater willingness to stop the initiated turn taking by the F NL H subject than by the F NL AD speaker in order to ensure that the speech flow will not be interrupted (Murdoch et al., 1987). It

may also be that the conversational partners of the F NL AD speakers were more dominant in their speech and that they forced the F NL AD subject to stop their speech by overrunning the initiated FaiTT overlap (Sabat, 1991).
Regarding the results of the UnF NL AD and the UnF NL H participants in the category FaiTT, we observed that in order to encourage the AD speakers, their conversational partners may be more willing to abandon their turn-taking (Ripich et al., 1991).

As AD speech tends to be highly routinized and AD speakers favour using briefer utterances then, even if spontaneous speech gets difficult due to limited planning and executive abilities, we may still see similar numbers of occurrences of FaiTTC overlaps as for the healthy speakers (Ripich et al. 1991).
It seemed that the UnF NL H speakers were more confident in finishing their turn, though they did not take the turn fully, than the UnF NL AD subjects.

There was no indicator that overall, the F NL AD speakers were more willing to take a risk in terms of overlapping than the F NL H subjects.
The UnF NL percent data showed higher values for the UnF NL H speakers than for the UnF NL AD subjects. The finding indicated that UnF NL H speakers perhaps used more features that we could find according to our categories.

FTD Patients

In this section, we will give an overview of the overall evaluation of our FTD data. Further, we will demonstrate the differences for the speakers within the F and UnF condition in order to show that the three subgroups may be distinguishable from each other by analysing overlapping in speech. Based on this finding, we continued analysis by case studies.

As we had data for only three FTD patients, one each representing SD, PNFA and bvFTD, and our aim was to differentiate those three sub-groups, we were not able to evaluate the data statistically. However, we presented the number of Overlaps, but showed, at the same time, differences between the subjects. Following this analysis, we took a case study approach supporting the descriptive statistics in order to demonstrate that our overall method is suitable for categorising AD *and* SD, PNFA, bvFTD speech.
In Chapter 7 and also in the following sections, we do not compare healthy, AD *and* FTD (SD, PNFA, bvFTD) data as the data sets' numbers vary greatly. If we did compare the data, we would distort the meaning and value of the subgroups' conversational behaviour regarding overlap

which may lead to wrong conclusions based on unbalanced data distribution, especially those for the SD, PNFA and bvFTD speakers.

Key findings

- FTD subgroups can be characterised by the categories, especially the category FTT showed a distinct characterisation for FTD speech
- The bvFTD and the PNFA conversations did not contain overlaps in the category Others
- A Familiarity effect may exist as well as we found differences between F NL FTD and UnF NL FTD data, in particular for the category Predictions
- The results of the F and UnF condition demonstrated that it is important to differentiate the individual speakers of each subgroup as they behaved distinctively regarding overlaps

<u>Suitability of the categories to measure categorical differences</u>

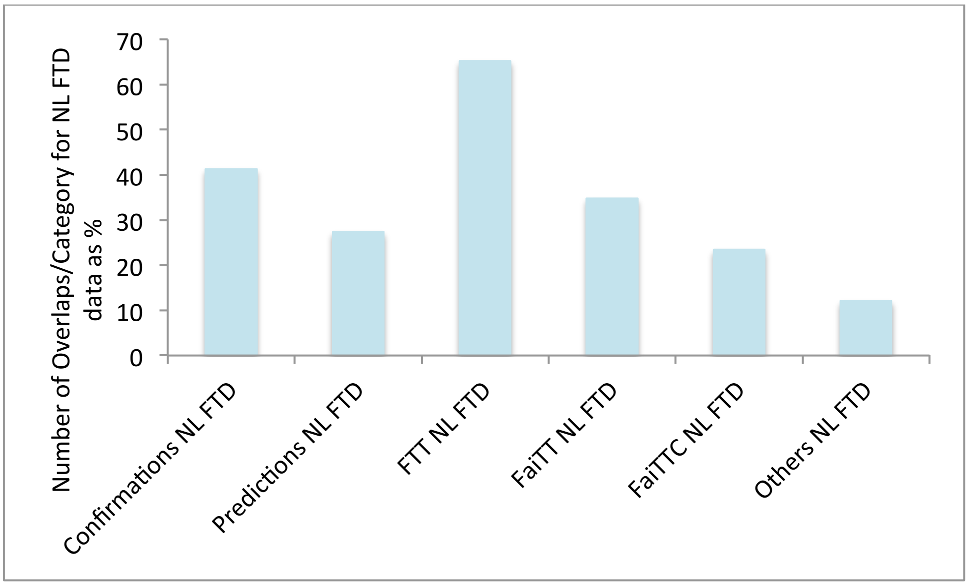

Figure 12 Number of Overlaps/Category for NL FTD data as %

The three FTD subjects revealed a high number of Confirmations overlaps, but were also still able to predict possible upcoming TRPs or TCUs (Figure 12), showing that the ability to follow the syntactical structures and processing of input and the speaker's own intention of how to interact were still preserved. For characterising the planning and execution of speech actions (overlaps), the FTD subjects were successful in taking the floor and also Completed FaiTT overlaps with a high percentage. Two conversations contained no overlaps in our category Others (bvFTD and PNFA). Again, our categories were able to draw the "contours" of FTD symptoms from the approach of analysing FTD speech by using overlaps.

Summary of the overall differences observed for H, AD and FTD data

By comparing the overall differences for each category of the NL FTD with the NL AD and NL H data, we observed higher values in three parameters in the NL H data (Confirmations, FaiTT and Others) than for the NL AD and NL FTD speakers. We found highest values for the categories FTT and FaiTTC in the NL FTD data and for the category Predictions in the NL AD data. Figure 13 displays an overall comparison of NL H, NL AD and NL FTD percentages of Overlaps.

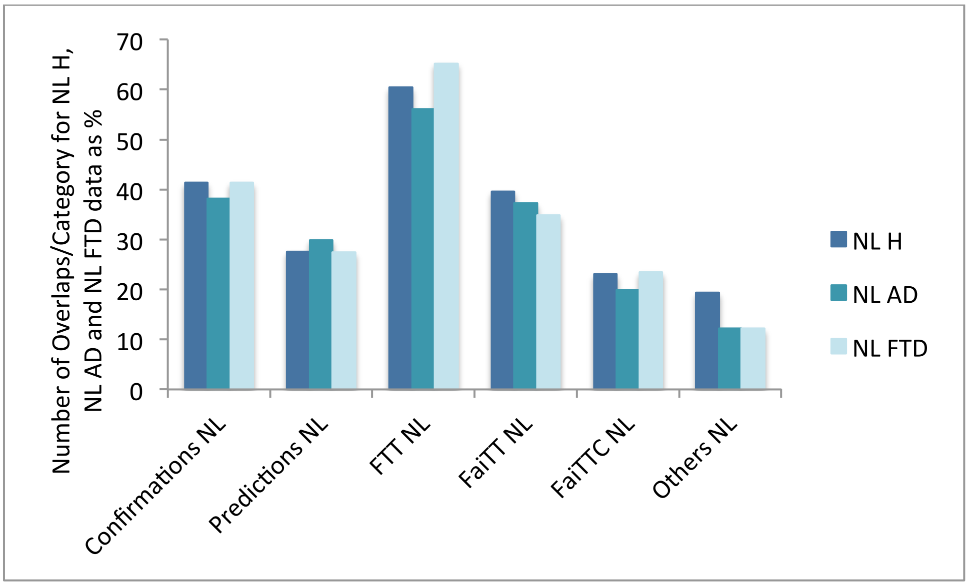

Figure 13 Number of Overlaps/Category for NL H (24 recordings), NL AD (15 recordings) and NL FTD (6 recordings) data as %

Familiarity effect

A possible Familiarity effect may exist for FTD speech as well. Our findings showed that the overall NL FTD data differed in the number of Overlaps depending on Familiarity (Figure 14). The greatest difference between the F NL FTD and UnF NL FTD data was found in the category Predictions (11.23%) and the smallest difference (2.55%) in the category FaiTTC. For the categories Confirmations, FTT, FaiTTC and Others, we found higher values for the UnF NL FTD subjects than for the F NL FTD speakers.

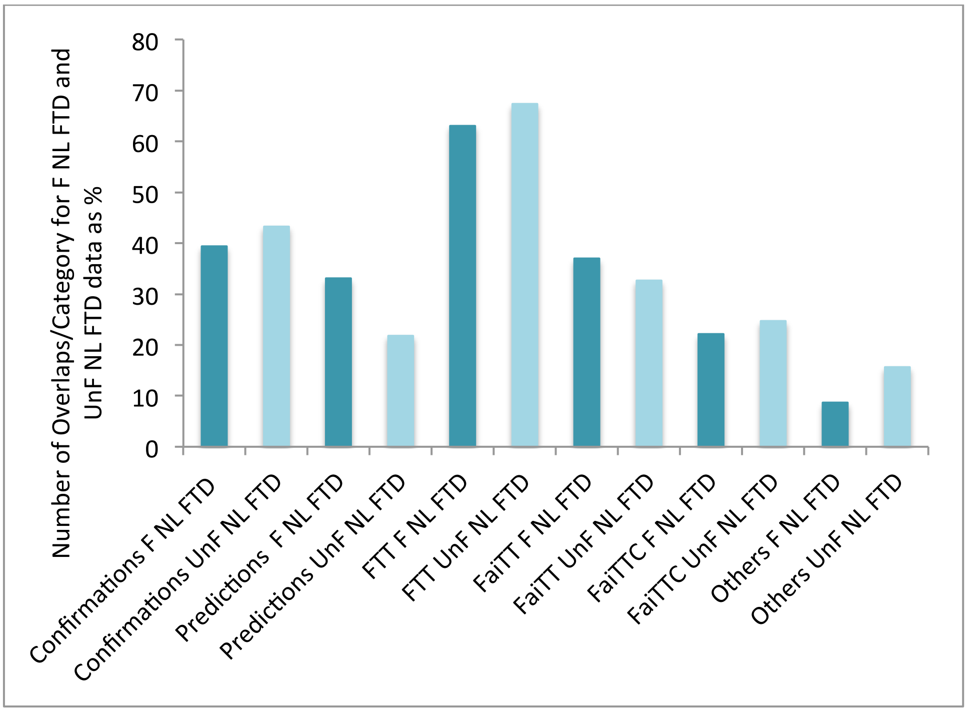

Figure 14 Number of Overlaps/Category for F NL FTD and UnF NL FTD data as %

Differences between the speakers within the F and the UnF condition

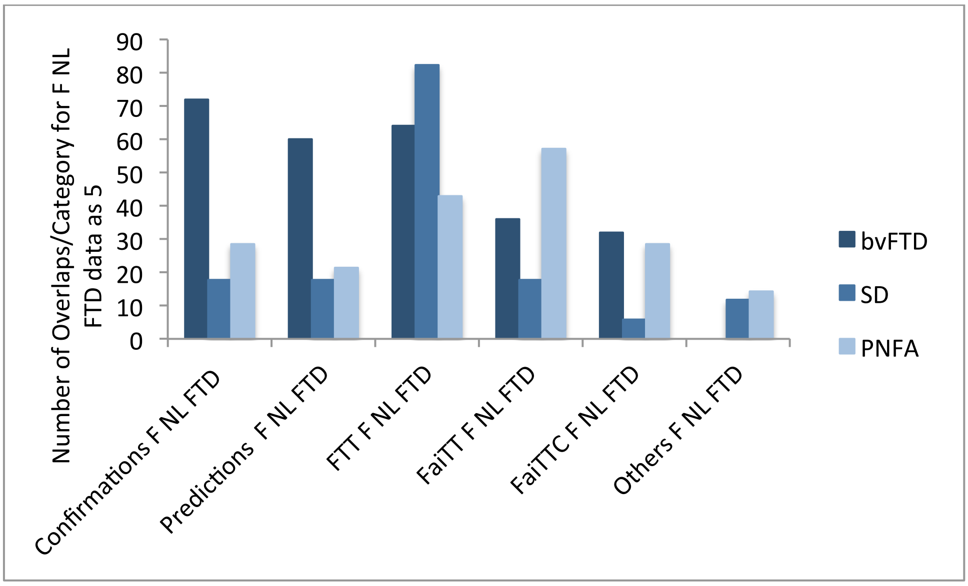

Figure 15 Number of Overlaps/Category for F NL FTD data as %

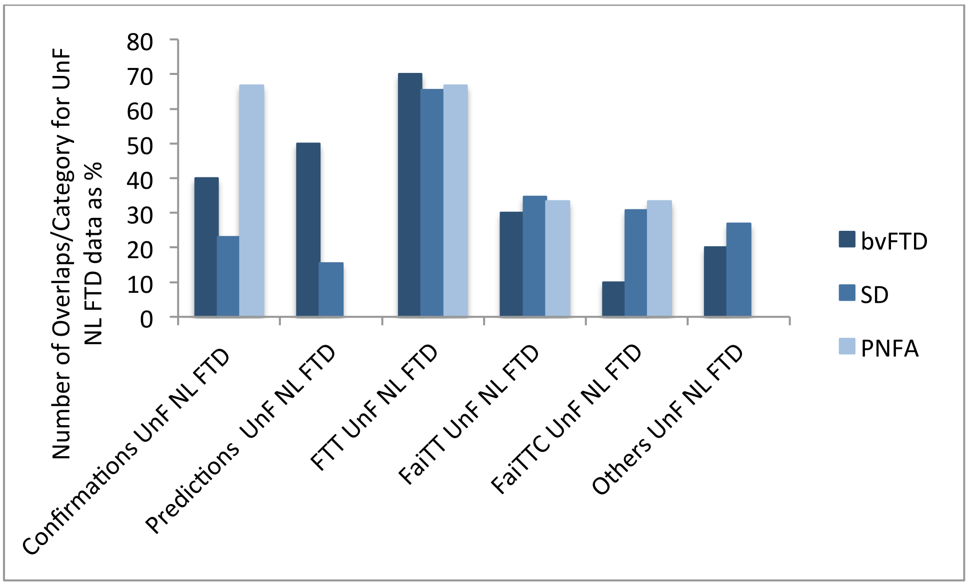

Figure 16 Number of Overlaps/Category for the UnF NL FTD data as %

The chosen overlap categories may be able to differentiate bvFTD, SD and PNFA speech within the condition as shown in Figure 15 and 16:

In the F condition, the categories Confirmations, Predictions and FaiTTC the bvFTD patient had the greatest percentage of overlaps. For the F NL SD patient, only the category FTT showed the highest number of Overlaps compared to the other speakers. The F NL PNFA speaker showed higher percentages in the categories FaiTT and Others than the F NL SD and F NL bvFTD speakers (Figure 15).

The categories Predictions and FTT revealed highest percentages for the UnF NL bvFTD patient in comparison to the UnF NL SD and the UnF NL PNFA subjects. FaiTT and Others showed higher percentages for the UnF NL SD patient and the categories Confirmations and FaiTTC revealed the highest percentages for the UnF NL PNFA speaker (Figure 16).

<u>Subgroups</u>

As the abovementioned results revealed, we found differences regarding the number of Overlaps for categories, for Familiarity and we showed differences within each condition for the FTD speakers demonstrating that the subgroups may be distinguishable by their conversational behaviour regarding overlapping. To extract more information about FTD speech, we decided to conduct case studies for each subgroup, differentiating the F and UnF condition.

<u>Semantic dementia - Familiarity effect</u>

We found that our SD patient produced more Predictions and FTT overlaps with a familiar than with an unfamiliar partner. These categories had an impact on the patient's conversational and overlapping behaviour. Four of six categories showed higher percentages for the UnF condition than for the F condition (Confirmations, FaiTT, FaiTTC and Others). All these categories may be subsumed under the patient's current condition: becoming more familiar with strangers and probably taking more conversational risks expressed by initiating overlaps. Her use of simple structured utterances due to word-finding difficulties led to more instances of these categories.

Due to greater differences the categories FTT, FaiTT, FaiTTC and Others seem to be good indicators for a possible Familiarity effect in SD speech.

PNFA - Familiarity effect

For the categories Predictions, FaiTT and Others, greater percentages for the F than for the UnF condition were found.

Being familiar with the conversational partner seemed to play a greater role for the PNFA patient when it came to predictability and the willingness to stop an initiated overlap. The parallel processing of grammatical structures and intentions of someone the patient was not familiar with may have been a reason for the high percentage number of Predictions produced under the F condition. A high rate of FaiTT overlaps under the F condition may indicate a greater acceptance of the husband's leading role. However, we found that all FaiTT overlaps had been Completed, revealing that though her utterances were short, she was able to finish her initiated overlap.

The categories Confirmations, FTT and FaiTTC revealed higher percentages for the UnF than for the F condition. In particular, the category Confirmations differentiated the F NL PNFA and UnF NL PNFA data with 38% indicating that our patient used feedback as a main feature of being able to take part and stay in the conversation with an unknown person. A certain conversational behaviour of the UnF L speaker provided BB time to express her thoughts and accepted an overlap more willingly, which led to a higher number of FTT overlaps.

Our observation demonstrates that a Familiarity effect is able to discriminate and characterise PNFA speech.

F NL PNFA data - Progression First and Second Recording

We found increased percentages from the first to the second recording for two categories: Confirmations and FTT. All other categories showed a decrease in the percentage for the PNFA patient.

We may say that for this PNFA patient, the change over time was mainly a decrease in the number of Overlaps. An increase of Confirmations overlaps may be explainable by the simple processing and production of feedback utterances which allow a contribution to the conversation with less effort. In the second recording, the husband motivated and encouraged the PNFA

patient even more than in the first one as her symptoms had worsened, leading to a cautious speech behaviour, in order to allow the patient to articulate her thoughts in her own time.
For further investigation, a greater number of subjects will show whether our observations can be strengthened or not.

bvFTD - Familiarity effect

The bvFTD patient initiated more overlaps of the category Confirmations, Predictions, FaiTT and FaiTTC in the F condition than in the UnF condition.
It seemed that the patient had increased timing difficulties within the conversation with his wife resulting in higher percentages for the number of Confirmations and Predictions.
It became clear that the patient acted based on Familiarity in terms of stopping or cancelling initiated turns more often, but also, due to his spouse's dominant leading of the conversation, to an increased number of FaiTT overlaps.
The UnF L speakers' speech behaviour on the other hand was more cautious and reluctant resulting in an increased percentage for the number of FTT overlaps.
He used short Confirmations overlaps more often in the conversation with his wife than with the UnF L subject. We suggest that he might want to demonstrate his participation in conversations and to react to the frequently initiated requestives by his wife.

bvFTD data - Progression First and Second Recording

By comparing the first and second recordings for the F and UnF percentages, we found, for both F and UnF conditions, an increase in the percentages for the categories Confirmations and FTT. We observed a decrease for both, F NL bvFTD and UnF NL bvFTD percentages for the category FaiTT.

UnF NL bvFTD data - Progression First and Second Recording

In the UnF condition, the bvFTD patient reduced his involvement in the conversation. However, the bvFTD patient mainly increased his initiation of overlaps of the categories Confirmations and Predictions. Simple structured phrases, such as feedback utterances, seemed easy to recall for the patient and were highly routinized in his speech repertoire. He further initiated Predictions overlaps once he was sure that a TRP would come up, especially in the second recording. He seemed to increase this behaviour in order to strengthen the impression of being part of the conversation.
A decrease of the percentages was found for the category FaiTT and Others.

F NL bvFTD data - Progression First and Third Recording

In general, the patient was less involved in the conversation and showed a reduced number of Words/Conv%. However, he increased the use of overlaps in the categories: Confirmations, Predictions and FTT. Almost all overlaps of the categories Predictions and FTT were short feedback utterances. Again, our bvFTD patient seemed to use simple and highly routinized phrases in order to strengthen the impression of him being part of the conversation though he may not have been able to follow the instructions or the conversation.

The decrease of the percentages of the categories FaiTT and FaiTTC may have been due to the changed conversational behaviour of his wife. As it was difficult to keep the patient interested in the conversation, she was more willing to step back and accept overlaps more often in order to reinforce her husband’s contribution.

For the bvFTD patient, we found a difference in conversational behaviour during the progress of the disease especially for those categories that include the use of simple structured utterances, mainly feedback.

11.1 Major Finding of this Study - Summary

Developing a method to avoid misdiagnosis in dementia and to identify subgroups of dementia was the aim of this study. We focussed on speech in dementia as the literature suggested that conversational behaviour of people with dementia is limited and will decrease over time. Therefore, Conversation Analysis and its claim to analyse the whole construct of communication rather than utterances and sentences in isolation was found to be a powerful methodology to differentiate speech in dementia from healthy speech, enabling a characterisation of both as well. We found that the number of overlaps in conversations is a promising measurement for analysing speech in dementia and for differentiating the subgroups from healthy speakers. Further, we found that conversational behaviour regarding overlapping is different for patients with dementia and healthy speakers if they interact with strangers.

This outcome may have an impact on the importance of automatic speech recognition systems (Tsai and Lee, 2010) in clinical assessments of dementia and its subgroups for a correct diagnosis at an early stage of the disease and for monitoring changes in conversational behaviour as well. The recorded conversations between a consultant and a patient could be analysed in real-time: the overlapping parts get extracted by speaker identification and matched with a (to be developed) dementia profile regarding the number of Overlaps. It seems possible that the number of Overlaps per Conversation can differentiate the subgroups of dementia as well.

11.2 Future Work

In this section, we will first demonstrate the constraints of this study and illustrate the influence of a larger cohort on to our findings. We will draw a frame for a new study. We will focus on what a future study could look like and what its probable application for an assessment by a neurologist might be. Naming the concrete next steps will be outlined at the end of the section.

Though we were able to give answers to the research questions with the limited data we had, we could not to collect and analyse enough data for comparing H, AD and FTD (PNFA, SD and bvFTD) speech in one (longitudinal) study due to time constraints. As our study design is able to characterise and differentiate conversational behaviour regarding overlapping, a comparison of H, AD, PNFA, SD and bvFTD speech may give insights in to the different organisation of turn-taking and may break similarities in speech and language pathology in to differences in order to avoid misdiagnosis.

Further, we were not able to analyse and monitor the progression of AD speech for the UnF condition, leaving the question open as to whether a Familiarity effect exists for the later stage of AD as well or not.

We did not analyse the L speakers' speech behaviour regarding overlapping due to time constraints, but we observed in the detailed FTD case studies that the patients' interlocutors changed or may have adapted their speech behaviour regarding overlapping depending on familiarity. We found characteristic strategies for the L speakers (e.g. taking the floor to support the patient if word-finding difficulties occurred) in order to guide the patient through the task. The number of Overlaps for the L FTD speakers varied throughout the conditions which in turn may have affected the conversational behaviour of the NL FTD subjects. This effect might be observable in conversations with AD speakers, too.

<u>Suggestions for a future study and "next steps"</u>

Larger cohort

As mentioned above, we strongly assume that our results and tendencies will be strengthened if a larger study is conducted.

For the patient study, there was a lack of recording sessions taken over a longer time period such as 2 or more years for each patient. This limited our ability to evaluate the changes of speech in dementia subgroups over time. A larger cohort may possibly increase the number of patients willing and able to participate more than once.

Random ordering of the F and UnF task

We did not consider a learning effect for the task in this study. For the patient recording sessions, we always recorded familiar pairs first in order to ease the situation for the patient. However, for the healthy study, this procedure was not practicable due to planning and scheduling recording sessions. An extended study would enable the possibility of conducting a better-controlled procedure considering an implementation of a random order of F and UnF recording sessions in order to look for a learning effect related to execution of the map task. In a larger study, it would be interesting to know if a learning effect exists and what the impact might be regarding a Familiarity effect. For the current patient study a possible learning effect may have influenced the number of Overlaps being used.

Intuitiveness of the categories

An investigation of the usability and intuitiveness for people annotating the conversations such as linguists and those who evaluate the results of our experimental design and analysis should be under examination, too. A questionnaire may be an excellent tool for an evaluation for the categories and their definitions to check on intuitiveness and user-friendliness.

A future study gives the opportunity of incorporating more linguists in order to define and judge annotations and transcriptions, which would test whether the categories' definitions are accurate and repeatable to a greater extent.

Additional categories

It may become evident that further categories or more detailed definitions of the categories are useful in terms of finding precise differentiation. We think that subdividing of categories may include more features relevant to characterise and identify dementia subgroups as we explicitly suggested for the categories Predictions and Others. By doing so, we might ensure that even nuances of dementia speech are detectable.

However, we found measurable evidence that further categories have yet to be defined as our categories Confirmations, Predictions and Others did not cover all types of overlaps. In Chapter 7.1 and 7.2, we found a gap of 11.68%% (healthy study) and a gap of 19.8% (AD study) between the sum of Overlaps of the categories Confirmations, Predictions and Others and the sum of Overlaps of the categories FTT and FaiTT (including FaiTTC). This in turn shows that additional categories have to be defined. A new category including "interruptions" per se could be introduced, capturing those overlaps that are neither close to completion points nor could they be categorised as Confirmations or what we defined as "Others" overlaps. By analysing the FTD subjects, we found topic changes which may also well belong in a category on their own.

Further definitions or categories may be more intuitive for a diagnosis than the six we have used here.

Analysis of L data

Further, we did not analyse the L data which may provide some new insights into interaction with dementia patients. However, in the case studies, we looked at the L speaker's behaviour and found certain strategies, e.g. taking the floor or giving more time to the patient to articulate thoughts and withdraw from speech, in conversational behaviour regarding overlap in order to guide the patient through the task.

The outcome of an analysis including the L subjects' conversational behaviour may help to readdress the difficulty of conversations in daily life and may offer strategies of handling conversations in a "smooth" way.

An analysis including L and NL speakers will clearly influence and probably improve the understanding of conversational behaviour in a clinic environment. Especially, an analysis of UnF data will provide benefits for the clinicians regarding an evaluation of the patient's speech at the appointment. Our findings may result in the use of a template displaying a certain overlap profile for each subtype for UnF conditions, based on the map task and the method presented in this study, in order to support the decision as to whether the patient suffers from AD or SD, PNFA or bvFTD.

Of course, the method can be extended to further subgroups such as Lewy Body as well.

Video-Analysis

Future research, based on our findings, may also include analysis of video recordings in order to analyse non-verbal communication behaviour in dementia.

For this project, we video recorded patients and their partners and also asked partners to complete a questionnaire as presented in appendix B. However, we could not collect enough data for valid analysis, as not all participants agreed to be video recorded and/or to fill in a questionnaire due to e.g. time pressure or other personal issues.

The preference for combining audio and video recordings is based on the fact that the executive limitation may become apparent as the organisation of cognitive activity and muscle mass control may behave contradictive. Gorno-Tempini et al. (2011) mentioned that the PNFA patient's effortful speech could be related to the deficit in articulatory planning rather than to an increased deterioration in cognitive loss at the beginning of the disease, which might be connected to the deterioration of muscle mass in dementia, too.

Neary et al. (1998) noted that the loss of meaning of verbal and non-verbal concepts in terms of semantics is characteristic for FTD patients. This contrast could perhaps be observable in a speech task such as ours.
Rousseaux et al. (2010) showed that pragmatic difficulties could be observed in non-verbal communication such as adapting prosody, using regulatory mimogestuality, managing speech turns and feedback. These limitations have a deep impact on social interaction and are therefore worth looking at in greater detail.
The decline of muscle strength and the constraints of organising non-verbal communication might result in a diagnostic feature for AD and FTD when compared to the actual speech behaviour.

An analysis, combining audio and video recording as well as the results of a questionnaire about speech changes may be helpful for an holistic evaluation of the patient's speech behaviour.

Next steps

If this study were to be continued, the concrete "next steps" should include an attempt at increasing the number of participants. An enlargement of the data sets by inviting other hospitals and organisations to become part of the study has to be aimed for. A new ethical application or at least an amendment would be needed.
It is strongly advisable that more than one or two linguists should code the conversations regarding overlapping, ensuring the intra-rater reliability.
Before analysing the L data and randomising the F/UnF conditions for the patient recordings, the definitions and the intuitiveness of the categories should be checked by experts (e.g. linguists, neurologists, clinicians) for reliability and repeatability. As suggested above, a questionnaire may be a good evaluation tool.
After the new frame for the study is set (larger cohort, intuitiveness and user-friendliness of categories, new or re-defined categories), the details of the new recording process (e.g. randomising order) can be defined and the analysis (e.g. application of other statistical tests, video-analysis) should be discussed.

Appendix A Levelt Model and Speech in Dementia

Locating speech impairments in Frontotemporal Dementia and Alzheimer's Disease within the Levelt model of speech production

Abstract
Dementing illnesses such as frontotemporal dementia (semantic dementia (SD), progressive non-fluent aphasia (PNFA) and behavioural-variant frontotemporal dementia bvFTD) are often misdiagnosed as Alzheimer's disease (AD) leading to inappropriate disease management. All are characterised by abnormal breakdown in fluent speech due to disruption in brain networks. Some of these dementia groups have speech and language impairments in common, but there are notable differences as well. This paper explores the similarities and differences by locating each disease within the Levelt speech production model (Levelt, 1983). The pattern of similarities and differences becomes explicable when viewed through the framework of the Levelt model, though ambiguities regarding the optimum location for some conditions remain due to the serial nature of the model and the multiple tasks carried out by some of its stages. The potential for more targeted speech tasks to be designed to assist with differential diagnosis is noted.
Key words: Frontotemporal Dementia, Alzheimer's Disease, Speech Impairments, Levelt Model, Speech Production

Introduction
Communication and understanding of words require a range of cognitive resources including lexical, semantic and perceptual processing. Such language processing is frequently disturbed when temporal and frontal cortical areas of the brain are affected by disease (Cycyk & Harris Wright, 2008; Neary et al., 1998). Further, the organization and interaction undertaken during conversation depend on the ability to plan and to exchange information (Peelle & Grossman, 2008). These executive functions, such as structuring and organizing, may be impaired when brain networks are disrupted. Abnormal breakdowns in fluent speech can particularly be observed in frontotemporal dementias (FTD) or Alzheimer's disease (AD), in both of which, brain atrophy in frontal and/or temporal area(s) is common.
Misdiagnosis in the more rare forms of dementia is common and frontotemporal dementias are frequently mistaken for Alzheimer's disease (MacDonald, Almor, Henderson, Kempler & Anderson, 2001), leading to potential frustration for the patients, since they receive unnecessary and ineffective therapy and disease management, and also imposing a high treatment cost on society.
FTD has a number of subgroups: (semantic dementia (SD), progressive non-fluent aphasia (PNFA) and behavioural-variant frontotemporal dementia (bvFTD)), and each shows different speech impairments during the progression of the disease. Likewise, certain speech behaviours are characteristic of Alzheimer's disease. Speech deficits are an aspect of the general diagnostic criteria for dementia and the specific criteria for all subgroups of FTD and for AD (Gorno-Tempini et al., 2011; McKhann et al., 2011; Rascovsky et al., 2011; Snowden et al., 2011). However there can be quite significant overlaps in speech behaviour between the different dementia groups as well. Thus speech deficits alone are not currently sufficient for a differential diagnosis between dementia groups or subgroups.
The cognitive disruptions caused by these diseases manifest themselves in the speech production process. It may be, therefore, that clearer understanding of the relationship between the speech deficits and the process of speech production could lead to an enhanced place for speech analysis in the diagnostic process. We propose to ground the observed speech behaviours in the well-established Levelt model of speech production (Levelt, 1983, 1989, 1992, 1999, 2001;. Levelt, Roelofs & Meyer, 1999) which is already successfully applied in research on aphasia and on apraxia of speech (AoS) (Varley & Whiteside, 2001) where it is found to explain specific speech impairments and is used in several therapeutic applications (Schade & Vollmer, 2000).
In diagnosis, clinicians are often faced, not only with overlapping speech symptoms of the dementia subgroups, but with symptoms found in other diseases as well, for example AoS,

aphasia and Parkinson's disease (Benke, Hohenstein, Poewe & Butterworth, 2000). The Levelt model has been successfully implemented in research on speech disorders of motor planning and disorders resulting in the inability to produce and comprehend language (Bastiaanse, 1995; Varley & Whiteside, 2001; Ziegler, Thelen, Staiger & Liepold, 2008). The model is used to explain the observed speech and language symptoms and to suggest improved and more specific speech therapy approaches (Schade & Vollmer, 2000). Speech and language limitations related to lexical retrieval such as word-finding difficulties or agrammatism become describable by using the speech production model of Levelt.

One subgroup of dementia in particular, PNFA, shares a significant number of symptoms with AoS and/or aphasia as well as AD, SD and bvFTD speech behaviour and we therefore hypothesise that the Levelt model can also be used as a framework to assist in diagnosis of these dementias.

A relationship between Levelt's speech production model and speech in dementia has not been comprehensively developed to date. We propose that FTD and AD speech abnormalities can be located within the Levelt model, and that the model can help to explain the early speech symptoms in SD, PNFA, bvFTD and AD patients providing a basis for better understanding of the distinctions and commonalities between their speech error patterns. This is, as far as we know, a new approach for classifying speech in people with PNFA, SD, bvFTD and AD.

The Levelt model

The Levelt model, shown schematically in Figure 1, proposes a detailed description of the entire speech production process, from the conceptualisation to the articulation of an utterance. It is a model in which the individual components work largely independently from each other with the output from one forming the input to the next. According to Levelt the production is incremental: "[...] the next processing component in the flow of information can start working on the still incomplete output of the current processor" (Levelt, 1999, p.6). Levelt assumes that the process may be both partially parallel and also serial on several levels (Levelt, 1999; Levelt et al., 1999). Various processing components are simultaneously active to allow information flow at an acceptable rate. The simultaneity accounts for real time production; "when we are uttering a phrase, we are already organizing the content for the next phrase, etc." (Levelt, 1999, p.88-89).

Insert Figure 1 here

On the top level, the conceptualiser generates a preverbal message of the intended utterance. The concept is based on the world, context and discourse knowledge, to which the conceptualizer has permanent access (Gotto, 2004). Next, suitable phonologically unspecified lexical items (lemmas) from the mental lexicon, get activated. According to Levelt, lemmas are specified in terms of semantic as well as "[...] in terms of syntactic category" (Levelt, 1983, p.48). The lemma with the highest activation passes from the conceptual level to become grammatically encoded. A syntactic surface is formed, based on the information about the lemma's syntax, and leads to the formal encoding including morphological and phonological generation of the item. At this level, information about the metrics and the segmental structure of the lemma produces a phonological score which finally creates an abstract representation of phonemes in a metrical frame. The phonological word then gets phonetically encoded. Discrete and context independent phonemes are transformed into a continuous and context dependent phonetic representation. The result is the phonetic plan: also called the "gestural" or "articulatory" score (Levelt, 2001, p.13465). This score specifies how the word has to be articulated and is also referred to as "internal speech" (Levelt, 1983, p.49).

The internal speech will be converted into "overt speech" (Levelt, 1983, p.49) which is audible for the speaker and the listener, by using the articulators (speech organs). If a formulation as part of the phonetic plan occurs while the articulator is still busy with a previous utterance, these asynchronies are held active in the "articulatory buffer" (Levelt, 1989, p.414) for later execution as motor programmes (Dewaele & Furnham, 2000).

According to Levelt (Levelt, 1983, p.49) the "process of message construction, formulating, and articulating [are] essential components of all speech production".

Levelt adds two further components to his model: a parser and a monitor. When a speaker produces audible speech it passes through the speaker's auditory system to the parser, which represents it in terms of its phonological, morphological, syntactic and semantic composition. Levelt also proposes that the parser can process internal and pre-articulatory speech: "The parser should not only be able to draw on overt, auditorily available speech, but it should be able to parse inner speech as well" (Levelt, 1983, p.49). The monitor compares parsed items of inner and overt speech with the speaker's intentions for the message by comparison with the preverbal messaged generated by the conceptualiser.

Levelt suggests that error and ambiguity detection and correction are handled by the parser and monitor. This can happen when the monitor compares the output of the conceptualiser with the original intentions of the speaker, when the internal speech is passed through the parser enabling errors in morpho-phonological or syntactic encoding to be detected and finally in the overt speech, again via the parser, when phonetic encoding and articulatory errors can be detected (Kormos, 2014). Errors and ambiguities may be repaired by restarting the production process. If a problem is detected, the monitor notifies the speaker and sends a signal to their working memory. A cut and restart action takes place. This restarting reinstalls aspects of the original utterance which were parsed correctly and may add revised versions of the incorrect parts. The efficacy and control of self-repair is dependent on the usual limitations of the working memory (Levelt, 1983). Errors detected in the conceptual preparation or in the morpho-phonological or grammatical coding may be repaired prior to audible speech production.

For economy, Levelt posits that the parser and monitor are the same systems as are responsible for processing speech produced by other people. Further, that the parser uses the same lexicon as the speech production system, albeit perhaps with limited access, and that the monitor is an embedded part of the conceptualiser. Indeed there
(Tagamets, Cortes, Griego & Elevag, 2014).

Speech changes in dementia: Relating the diseases to the Levelt model

Lexical retrieval embraces retrieval from the knowledge of the internal and external world and retrieval from the mental lexicon. Following the definition of Badecker, Miozzo & Zanuttini (1995), lexical retrieval is performed in two stages: First, the representation of a message concept maps into "modality neutral lemmas" (Badecker et al., 1995, p.205) (abstract conceptual word form) within the lexical selection stage;

Second, the lexical form is retrieved, based on the lemma's information about syntax and semantics. This description of lexical retrieval allows differentiation of the process between the various subgroups of dementia.

In the past, a few studies relating speech in dementia to Levelt's theory of the speech production process have been reported. Meteyard & Patterson (2009) stated in their paper about speech errors in SD that this subtype of dementia shows disturbance in speech on the level of concept and is considerable evidence that, at least up to the articulation phase, the processes and brain regions involved in monitoring self-generated and external speech are largely shared preverbal message generation. They considered an impairment at the lexical retrieval level as plausible as well.

Grossman et al. (2004) suggested that, though all FTD subgroups and AD patients show difficulties in lexical retrieval, the "qualitative differences in the nature of their lexical retrieval" are different (Grossman et al., 2004, p.630). They proposed the so-called "large-scale network" approach which differentiates the distinct profiles of the dementia subgroups in terms of deficits in certain cognitive components of the naming process (or lexical retrieval).

In the following sub-sections, we will match PNFA, SD, bvFTD and AD speech behaviours to the levels of the Levelt model.

Semantic dementia (SD)

The International Consensus Criteria for diagnosis of primary progressive aphasia (PPA), a variant of FTD, require (Gorno-Tempini et al., 2011) that :

1. Most prominent clinical feature is difficulty with language

2. These deficits are the principal cause of impaired daily living activities
3. Aphasia should be the most prominent deficit at symptom onset and for the initial phases of the disease

Further, for a diagnosis of Semantic Dementia (also known as semantic variant PPA) there should be both:

1. Impaired confrontation naming
2. Impaired single-word comprehension

And at least 3 of the following:
1. Impaired object knowledge, particularly for low-frequency or low-familiarity items 2. Surface dyslexia or dysgraphia
3. Spared repetition
4. Spared speech production (grammar and motor speech)

People with SD speak fluently, but their speech may convey relatively little information (Peelle & Grossman, 2008). SD speech is grammatically well-formed; syntax, phonology and articulation are relatively preserved (Hodges & Patterson, 1996). However SD speakers may have significantly slower speech than healthy people (Ash et al., 2009).
The major symptom of SD is, as its name suggests, disturbed semantic processing. According to Peelle & Grossman (2008), SD speakers exhibit word-finding pauses, circumlocutions and expressions that substitute for specific nouns (e.g. “thing” or “stuff”), though frequently used and familiar objects make a positive contribution to their semantic processing. For words whose meaning has been lost, phonological mistakes can be observed. Further, some SD speakers show difficulty in pronunciation or writing of irregularly spelled words. Nevertheless, SD speakers present preserved phonological processing (Peelle & Grossman, 2008).
Jefferies & Lambon Ralph (2006) compared the semantic impairment in stroke aphasia (SA) and SD. Their aim was to show that there are differences between the comprehension limits in SD and SA. Both groups recruited to the study, 10 SD and 10 SA patients, had word-finding difficulties which affected fluency of speech. The SD speakers showed impaired semantic knowledge and single word comprehension deficits. As is typical for SD speech, phonology and syntax were relatively well preserved. The authors used several semantic tests: the camel and cactus test (Bozeat, Lambdon Ralph, Patterson, Garrard & Hodges, 2000) where participants have to “decide which of four semantically related items is most associated with a stimulus” (Jefferies & Lambon Ralph, 2006, p.2136), a spoken word-picture matching task and spoken picture naming where patients were asked to name the item presented as a Snodgrass picture (Snodgrass & Vanderwart, 1980). Further tests included an environmental sound task (matching sounds to pictures and words) and the Boston Naming Test (Kaplan, Goodglass, Weintraub & Goodglass, 1983) (patients were asked to name 60 items). The study revealed that degradation in semantic knowledge could be observed for all test modalities for SD speakers. It was concluded that the SD speakers, unlike the SA cohort, had a global degradation of the semantic representation.
On this evidence, in particular the amodal loss of semantic knowledge reported by Jefferies & Lambon Ralph (2006), it seems likely that the speech disruption in SD can best be mapped to the upper part of the Levelt model. The construction ability for generating a new (preverbal) message seems to be lost in SD. The access to semantic knowledge is interrupted, resulting in difficulties initiating the grammatical encoding and activating the required complex lemma; indeed the SD speech behaviour suggests deficits in access and activation of the mental lexicon due to missing input from the conceptualiser (Meteyard, Quain & Patterson, 2014). Discourse knowledge and the access to knowledge of the external and internal world are disturbed. If the intended preverbal message is ambiguous, the “wrong” lemma for an utterance may get activated. Nonetheless, the grammatical encoding and all following speech production steps leads to a correct processing of the lemma. As syntactic structures are usually highly routinized and automatically produced, normal conversational speech in SD does not always show syntactic difficulties (Meteyard &

Patterson, 2009). SD speakers show a reduction of complexity and variation in their utterances as they fall back on “routinized phrases, filler terms and a familiar vocabulary” (Meteyard & Patterson, 2009, p.37), especially in the later stages of the disease where syntax may be affected. The comprehension of conversation by people with SD appears to be good (Hodges & Patterson, 1996) allowing us to assume that the parser is intact, at least at the onset of the disease. We might likewise hypothesise that the monitor itself is functioning yet it does not initiate a repair to the utterance, suggesting that it matches to the concept as initially generated. If it is the initial concept itself, used by the monitor as a reference, that is erroneous it cannot detect that there is an error and raise the alarm with the speaker. If a SD speaker has no access to discourse knowledge, she is not able to reflect on or monitor her own speech correctly, in terms of changing simple substitute expressions like 'thing' into concrete nouns.
Based on the abovementioned assumptions and conclusions, we locate the SD speakers’ problem in the conceptualiser of the Levelt model.

Progressive non-fluent aphasia (PNFA)
In addition to the general diagnostic criteria for PPA noted in section 3.1, the international consensus criteria for the diagnosis of progressive non-fluent aphasia are (Gorno-Tempini et al., 2011) that at least one of the following core features must be present:
1. Agrammatism in language production 2. Effortful, halting speech with inconsistent speech sound errors and distortions (apraxia of speech)
And at least 2 of the 3 following other features must be present:

1. Impaired comprehension of syntactically complex sentences
2. Spared single-word comprehension
3. Spared object knowledge

PNFA is a disorder affecting expressive language where the working memory is impaired (Adenzato, Cavallo & Enrici, 2010; Peelle & Grossman, 2008). PNFA speech is characterized by effortful speech production, grammatic and phonological errors as well as difficulties in word retrieval (Neary et al., 1998). PNFA speakers show high rates of phonological paraphasias in naming (e.g. “papple” for apple, “plants” for pants), reading aloud and in word repetition (Grossman, 1996; Peelle & Grossman, 2008). According to Peelle and Grossman (2008) semantic knowledge is relatively well-preserved. Their observations are in accordance with the results of Grossman et al. (1996) who noted that PNFA speakers are impaired “[...] on grammatical phrase structure aspects in sentences comprehension and expression, phonemic judgements, repetition [...]” (Grossman, 1996, p.135).
Gorno-Tempini et al. (2011) note that the agrammatism takes the form of speech with short, simple phrases, inflections and omissions of grammatical morphemes. The effortful speech production was thought to be due to the PNFA patient's deficit in articulatory planning which leads to inconsistent speech sound errors (Gorno-Tempini et al., 2011). They further remark that the speech sound errors such as distortions, insertion, substitutions etc., are often noticed by the speakers themselves.
The research group around Rhee (2001) had a detailed look at the role of grammatical, semantic and executive components in FTD and its subgroups (Rhee, Antiquena & Grossman, 2001). For their comparative study, 21 FTD patients (bvFTD: 10, PNFA: 7, SD: 4) were assessed during a word- picture matching task for verbs and nouns. The speakers had to decide whether a presented word and the picture went together. Across all groups impairment in performance for both verbs and nouns was found. Performance in terms of both accuracy and time to make a decision was low for verbs compared to nouns. In PNFA subjects the authors noted reduced verb comprehension that was significantly correlated with reduced sentence comprehension. In comparison to the other subgroups, who showed either a correlation between information-speed processing of executive resources and impaired verb comprehension or difficulties in understanding verbs, PNFA speakers revealed difficulties in sentence comprehension related to the grammatical role of verbs. Rhee et al. (2001) suggested that “grammatical aspects of verbs play a crucial role in PNFA speakers’ verb comprehension difficulties” (Rhee et al., 2001, p.173).

As verbs are complex in terms of assigning them to the correct grammatical form class and processing their semantic attributes, they are ideal to give evidence as to whether one or both of these features are limited.

Evidence for impaired grammatical processing was given by Murray, Koenig, Antani, Mccawley & Grossman (2007). In their comparative study: 25 FTD subjects (PNFA: 6, SD: 11, bvFTD: 7, Control: 17) were taught the very-low frequency English word “lour” (= “to look angry or sullen as if in disapproval”, (Murray et al., 2007, p.4) which was expected to be unfamiliar to most participants. After exposing the subjects to a narrated picture story including the new verb, the participants had to perform a sentence-picture matching task and a grammatical sentence acceptability task (subjects were asked to judge the acceptability of 48 sentences that varied in grammatical appropriateness). The researchers assessed the subjects’ mental representation of grammatical, and semantic aspects of “lour”. PNFA patients did not show any difference in their acquisition of the meaning of the new verb in comparison to the healthy group. They were able to distinguish “lour” from pseudowords, suggesting that PNFA subjects have an intact capacity of semantic representation. They also pointed out that PNFA participants were able to acquire sufficiently the phonologic features of “lour”. Where PNFA subjects showed limitation was in the acquisition of understanding of the grammatical features of a novel lexical entry.

Ash et al. (2006) focussed on discourse impairment in frontotemporal dementia. The authors examined narratives told by 35 FTD participants from a children's picture book (“Frog. Where are you?”). The transcribed narratives were analysed for duration, number of utterances/words, lexical retrieval difficulty, content, action, global connectedness, search theme and local connectedness. MRI scanners were used to evaluate the relationship between cortical atrophy and the local connectedness of narrative organization. All subgroups showed impairments in performing the task. PNFA subjects showed an effortful behaviour in speech production, resulting in sparse narrative, significantly reduced fluency and abbreviated utterances. The authors suggest that reduced mean length of utterance (MLU) is a signal for “impoverished sentence-level grammatic production” (Ash et al., 2006, p.1412). They also noted the incorrect use of grammatic forms for the PNFA group.

On the basis of the studies described, in PNFA, we hypothesise that the grammatical encoding is impaired. At the early onset of the disease, adequate conceptual preparation seems to take place and the idea of “what to say” seems present suggesting that, in terms of the Levelt model, the conceptualiser is intact. The process of using the mental lexicon is the point of no return for PNFA speakers, who seem to have a semantic memory deficit, especially for verbs and their associated actions, which does not appear to be a result of a deficit in the message generation (conceptual preparation) (Koenig, Smith & Grossman, 2006). All components below this grammatic encoding step seemed spared, but the error generated at the higher level propagates through the subsequent processes through to the articulation level. Grossman et al. (1996) showed that the episodic memory function is relatively well-preserved in PNFA. This finding further supports our hypothesis that the conceptualiser is intact and it is the encoding afterwards which is disturbed. The disturbance in articulatory planning, i.e. speech sound errors is an interesting point in terms of its location in the Levelt model. Apraxia, effort and hesitation may arise from a direct disruption to the motor system, but may equally be due to the propagation of the grammatical encoding failure and is perhaps also related to attempts at repair. It is not therefore necessarily the case that we must consider two separate locations for disruption in the Levelt model for PNFA. Gunawardena et al. (2010) conducted a study to compare fluency (defined as words per minute (WPM) from a large semi-structured speech sample) between 16 people with PNFA, 12 with bvFTD and 13 healthy age- matched controls. Linear regression analysis was used to relate WPM to grammatic (complex grammatic structure per utterance), motor-speech planning (speech sound errors per total number of words) and executive aspects of patient function. WPM was found to be significantly reduced in subjects with PNFA compared to the other groups and further, only grammatic measures significantly predicted WPM for the PNFA speakers. This study supports the idea of a single deficit in the grammatical encoding alone rather than a pair of deficits one in the grammatical encoding and another in the articulatory encoding.

The fact that PNFA speakers do often recognise their mistakes in the early stages of the disease (Gorno-Tempini et al., 2011), supports an assumption that the parser and monitor are both initially intact. An alternate assumption could be that the parsing is only partially working such that PNFA subjects are able to monitor overt speech for accuracy, but not inner speech with the result that attempted repairs are less likely to be made prior to articulation. Self-monitoring, becomes disturbed as the disease progresses. Accepting that the same comprehension system is processing both the speaker's own speech and that of others (Levelt, 1999) the verb comprehension difficulties, related to their grammatical role, encountered when perceiving other's speech (Rhee et al., 2001) could indicate that the disruption in the function of the parser is also at the syntactic level.
Based on the results and findings of the studies mentioned, above, we find evidence that the grammatical encoding process is disturbed in PNFA. The conceptualiser is still intact at the earlier stages of the disease as semantic processing is operational. Failures in articulation in terms of speech sound errors, hesitations and effortfulness of speech are considered to be a consequence of the disrupted grammatical encoding.

Behavioural-variant frontotemporal dementia (bvFTD)
The international consensus criteria for the diagnosis of bvFTD are given by (Rascovsky et al., 2011) as:
1. Shows progressive deterioration of behaviour and/or cognition by observation or history (as provided by a knowledgeable informant) and
2 or 3 of the following:

- Early behavioural disinhibition;
- Early apathy or inertia;
- Early loss of sympathy or empathy;
- Early perseverative, stereotyped or compulsive/ritualistic behaviour;
- Hyperorality and dietary changes;
- Neuropsychological profile: executive/generation deficits with relative sparing of memory and visuospatial functions;

where early is in the first 3 years. Within the fourth subcategory: perseverative behaviour, one of the symptoms may be stereotypy of speech.

Thus altered speech patterns are only one of a very large number of changes that may be observed in this dementia subgroup. In bvFTD, executive dysfunction is thought to account for language impairments resulting in deficits in naming and sentence comprehension as well as discourse processing problems (Peelle & Grossman, 2008; Piguet, Hornberger, Shelley, Kipps & Hodges, 2009). It has been shown that bvFTD speakers have a profound impairment in judging the intentions of others which has an impact on their conversational abilities (Eslinger, Moore, Antani, Anderson & Grossman, 2012; Leyton & Hodges, 2010; Peelle & Grossman, 2008). In order to predict intentional behaviour, interlocutors interpret each other's behaviours which are caused by beliefs, hopes and wishes Levelt (1999, p.84) named this interpretation ability the "Theory of Mind" (ToM). Levelt (1999, p.85) noted that the ToM allows conversational partners to build up complex structures of knowledge about social attitudes: "Over and above registering Who did What to Whom, we encode such complex states of affairs as 'A knows that B did X', 'A believes B did X', 'A hopes B does X', 'A fears that B does X', 'A erroneously believes that B knows X', 'A doesn't know that B hopes X', and so on''. In the comparative study related to discourse analysis, described in Section 3.2, Ash et al. (2009) investigated all three FTD subgroups in relation to speech fluency. The authors suggested, based on the literature, that fluency is the ability to produce conversational speech in a flowing, effortless way. Recordings of narratives were analysed for fluency (complete WPM, speech errors per utterance, grammatical structure, content features (length (words) per utterance, complex grammatical structures per utterance, semantically limited sentences, verbs/nouns per utterance)). MRI scans were made to investigate cortical atrophy. It was found that bvFTD subjects produced significantly slowed speech and showed impairment in accessing the mental lexicon. The executive measure: category naming fluency, was found to be correlated to the speech rate. Ash et al. concluded that apathy and poor mental organization contributed to the reduced speech fluency. The participants showed impaired discourse with poorly organized expression which was attributed to a limitation of executive functioning. The authors found extensive frontal and temporal cortical atrophy in bvFTD subjects and inferred from that the source of the limited planning and organization in bvFTD speech. Generally, frontal networks are associated with fluency and grammaticality of speech production (Pakhomov et al., 2011).

Koenig et al. (2006) published a study considering semantic categorisation ability in FTD. Their aim was to separate knowledge and processing components in the semantic memory to identify a group specific impairment source. By using a similarity- and a rule-based categorisation task in which the participants (initially SD: 7, PNFA: 7, bvFTD: 5 and controls: 19) had to decide firstly which of the two presented animals depicted on a card is similar to a fictitious pictorially-presented prototype animal (similarity-based) and secondly which animal of two presented pictures has the most concordant features to the prototype animal (rule-based). The results showed that bvFTD subjects displayed a poor rule-based performance. Though the results for the two groups were similar, Koenig et al. differentiated PNFA and bvFTD subjects by the source of their impairment. The authors argued that bvFTD speakers had the greatest categorisation impairment; they had difficulties with rule-based categorisation of familiar objects. Koenig et al. proposed, based on the observed difficulties with familiar object categorisation, that deficits in bvFTD speech are "[...] not influenced by the familiarity or recency of knowledge" (Koenig et al., 2006, p.559). However, they concluded that bvFTD speakers may have a rule-based deficit rather than a similarity-based categorisation deficit due to their difficulty in processing social knowledge. They argued that as bvFTD shows a degradation in social knowledge and as this domain is relatively unstructured and underspecified, bvFTD speakers' rule-based categorisation deficit could contribute to their difficulty in processing social knowledge: If processing of social knowledge is impaired, processing of semantic knowledge, which may be considered another similar form of rule-based processing, might also be impaired for the same reason in this subgroup of dementia.

Whilst PNFA speakers show difficulties with the grammatical encoding and SD speakers reveal disturbance in the conceptual preparation (see previous sections), bvFTD speakers' access to the mental lexicon as well as the "knowledge of external and internal world" (Levelt, 1999, p.87) both seem to be damaged as a result of their reduction in executive functions.

That people with bvFTD have difficulty holding a conversation is understandable in the context of impairment of the conceptualiser influencing conceptual preparation. The explicit lack of empathy differentiates bvFTD from SD in the degree of their respective speech impairments and in their specific representation in the Levelt model. Whereas people with SD's access to the knowledge of the external and internal world is disturbed, people with bvFTD seem, on the evidence of their relatively well-preserved semantic processing, to have partial access to this knowledge. In other words, bvFTD does not have a huge impact on the person's representation of knowledge, but appears to give rise to difficulties in processing this knowledge to establish a meaning (Koenig et al., 2006). The executive deficits in bvFTD "[...] may contribute to more subtle semantic processing difficulties" (Peelle & Grossman, 2008, p.110) such that bvFTD speakers show mainly a language deficit in their conversational discourse.

There is no evidence to suggest impairment of the monitor, merely that limitations of the conceptualiser especially in relation to discourse limit the complexity of the initial message. A working parser may account for the observation that speech is slowed in bvFTD as this may arise from the initiation of repair based on the inner speech, however difficulties with sentence comprehension could be linked to limited parser function.

We propose based on the studies discussed in this section, that bvFTD subjects have a partially impaired conceptualiser: knowledge of the internal and external worlds seems preserved but access to discourse knowledge is interrupted, leading to difficulties in conversation. Pre-verbal messages are likely to be based on relatively simple conversational structures. The lack of concern, the impulsivity and/or the emotional blunting (Leyton & Hodges, 2010) have an impact on their communication limitations. Additionally, we suggest that the bvFTD subgroup has difficulties with access to the mental lexicon, manifested by the slow rate of speech production, reduced fluency, and difficulties in naming and in sentence comprehension.

Alzheimer's disease (AD)
According to McKhann et al. (2011) the diagnostic criteria for Alzheimer's disease are multi-faceted and require that a set of core clinical criteria for all-cause dementia, which may include impaired language functions such as difficulty thinking of common words, hesitations, and speech errors, are met and that in addition, there is:

- Insidious onset
- Clear-cut history of worsening cognition

Either deficit in learning and recall of recently learned information (amnestic presentation) or, in non-amnestic presentation, deficit in language, especially word finding, and/or deficit in spatial cognition and/or executive dysfunction. Brain atrophy results in decline of spatial, semantic long-term and working memory (MacDonald et al., 2001). By the middle stage of the disease, AD speakers show deficits in naming, pharaphasic errors and semantic jargon. In advanced stages, global aphasia and mutism are present (Blair, Marczinski, Davis-Faroque & Kertesz, 2007 . Spontaneous speech is highly affected perhaps caused by the lack of "pre-emptive planning or memorization of a response" (Guinn & Habash, 2012, p.8). Perseverated repetitional abilities, and impaired auditory comprehension are also observed. Semantics and pragmatics are impaired rather than syntax and phonology (Murdoch, Chenery, Wilks & Boyle, 1987; Singh, Bucks & Cuerden, 2001). In 1991, Ripich, Vertes, Whitehouse, Fulton & Ekelman found evidence that AD speakers are aware of their own confusion and tend to ask many "direct, forced choice questions to gain additional information" (Ripich et al., 1991, p.338). The authors looked at conversational discourse patterns in 11 healthy elderly and 11 AD subjects using a dyadic interaction with an interviewer (examiner). The speech was audio- and video-recorded and took place during a coffee break between testing consultations. The examiner acted as a peer and was instructed to avoid "interviewing" the patient. Measurements were taken on the basis of words spoken, conversational turns and speech act types (communicative intents). The study revealed that AD and control data had significant differences in turn taking and in word usage. The AD subjects used more turns, with briefer utterances and a greater quantity of requestives in order to participate effectively. However, conversational skills (form and communicative intent) were sustained. According to the authors the interactions were still recognizable as conversational turn takings. A study by Sajjadi, Patterson, Tomek & Nestor (2012) compared conversation abilities of SD, AD and healthy subjects (SD: 16, AD: 20 and healthy: 30 subjects respectively). The recorded speech samples were collected during face to face interviews, which were semi-structured, and by using a picture description task. The authors set their focus on T-units (units that convey a clear message in a clause/different clauses, units that include elliptical phrases, units which represent a failure of the speaker to convey a complete message), spontaneity (number of questions/encouraging comments) and rate (number of WPM), fluency and phonological errors (e.g. hesitations, editing breaks), lexical content and semantic processing (e.g. number of verbs/minute, circumlocutions), and grammatical errors. The results showed that no difference could be observed between SD subjects and healthy participants for phonological error frequency, discourse markers (word/phrases "[...] that function primarily as a structuring unit of spoken language [...]" (Sajjadi et al., 2012, p.852) and syntactic errors. However, the AD speakers showed a significant increase in the frequency of hesitation markers compared to the SD and the healthy groups. Further, the authors confirmed an impairment in semantic content and thematic coherence in AD speech. Unfortunately, Sajjadi et al. did not propose any explanation for these outcomes.
In general then, it seems discourse processing and semantic memory are disturbed in AD (Hodges, Salmon, & Butters, 1992; Singh et al., 2001). In terms of "discourse", we here adopt the idea of Johnson-Laird & Garnham (1980) who outlined the definition of a discourse model as "[...] a mental object that constitutes an individual's knowledge of discourse. It is constructed on the

basis of what has occurred in the discourse supplemented by general and specific knowledge" (Johnson- Laird & Garnham, 1980). Certainly, Levelt's term of "macroplanning" which is part of the conceptualisation (the speaker decides what to say next) conforms with this (Levelt, 1999, p. 90): "Given the communicative intention, the speaker will focus attention on something specific to be expressed ('the current focus'). [...] the speaker will monitor whether what should be said for realizing the communicative intention will be said. [...] the speaker will monitor whether the interlocutor is following the speech act". Levelt himself calls this "discourse focus". Based on those statements, two assumptions concerning the speech impairment location(s) may be made. For AD speakers:
First, the message generation seems to be disturbed as the semantic abilities are reduced (word-finding difficulties, empty speech etc.). The monitoring of discourse processing seems to be working and intact: AD speakers barely recognise their speech failures, perhaps because the representation in the first instance is missing in the speaker's memory. Furthermore, the occurrence of searching for words supports the notion that monitoring of cognitive processes is retained (Astell & Harley, 1996).
Second, the preverbal message and therefore the lexical concepts are not correctly processed which leads to an increased use of highly frequent words and of hesitations. These two aspects can be linked in the context of the Levelt model. Losing semantic knowledge and thematic coherence (discourse) can be associated with impaired pre-verbal message generation. This causes, word-finding difficulties leading to empty speech and an increase in hesitation markers. An increased use of hesitation markers also might be a consequence of an impaired retrieval of lexical concepts (stored linguistic knowledge units (Evans, 2009)).
A reported awareness of AD speakers to their limitations, at least in the early stages of the disease, suggests that monitoring is functioning, however impaired auditory comprehension may be indicative of problems with parsing outer speech correctly.
The literature suggests that, in AD, basic language structures such as turn taking behaviour, syntax and phonology are not impaired The conceptualiser, including the semantic knowledge and discourse knowledge seems to be the main source of disruption. Consequently, the lexical selection stage is compromised.

Discussion

A link between the Levelt model and each subtype of dementia and its speech impairments has been made. Figure 2 summarises this in diagrammatic form.

Insert Figure 2 here

We suggested that in SD the conceptualiser: which gives access to the knowledge of the internal and external world and is the highest level of the speech production process, is likely to be disturbed. Semantic dementia patients have difficulties with word-finding and sentence comprehension. We propose that the conceptual preparation is failing which leads to limited access to lemmas or words. If the concept is missing, the SD speaker is not able to activate the required lemma and will use highly routine syntactic structures. The outcome is slower speech and hesitations, but with relatively preserved discourse processing
PNFA speakers reveal agrammatic and disfluent speech which we propose is caused by impaired grammatical encoding of the preverbal message. The mental lexicon seems to be the source of the PNFA speaker's speech difficulties. Two conclusions are possible: Either a wrong lemma in the mental lexicon is activated which gets correctly encoded, causing interruption if the failure is noticed, or the information from the mental lexicon for the activated lemma gets incorrectly encoded which can lead to errors in the syntactic composition.
bvFTD speakers show severe difficulties in organising and planning speech. The access to discourse knowledge, part of the conceptualiser, seems damaged. Access to the knowledge of the internal and external world also gets affected. Speakers with bvFTD have difficulty with processing social knowledge and this influences their ability to stay in conversations and process discourse, though their representation of knowledge is relatively well-preserved at the early stage

of the disease. Further, people with bvFTD reveal difficulties in accessing the mental lexicon and show deficits in retrieving the structure for sentences. Failure to do so, leads for bvFTD to the typical significantly slower speech.

Alzheimer's disease speakers have an impaired conceptualiser which has limited access to the knowledge of the internal and external world, especially to the Theory of Mind. The loss of this crucial element significantly affects discourse processing. Decreased semantic knowledge leads to the use of high frequency words and circumlocutions and to a tendency for relatively short utterances. Hesitations make a fluent conversation hardly possible at a later stage of the disease. The increased use of hesitation markers might also be the result of a fault in the retrieval of lexical concepts.

The approach of locating the speech behaviour of the subgroups of dementia in the Levelt model is a challenging, but illuminating approach for understanding the speech of people with dementia and for addressing the cause of the overlapping of symptoms which lead to the problem of misdiagnosis. Our aim was to identify clearly the location of the speech behaviour in FTD and AD within the model. However, we had to make some deductions: it is not straightforward to distinguish between an impaired stage in the Levelt model such that it produces erroneous output, reduced processing of information within a stage such that the output is partially disrupted and disturbed access to the source for a given level. Further, disruptions in self-monitoring can be had to disambiguate from disruptions in the production process.

In terms of location in the model, SD and PNFA are distinct, AD has a single location and shares that with SD, but bvFTD overlaps with all other types of dementia considered here in location and in symptoms, sharing impaired sentence comprehension and lack of fluency with PNFA and reduced access to world knowledge with SD and AD, in particular a reduction in Theory of Mind is shared with AD. AD and SD both show grammatically and phonologically well-formed speech but with greatly reduced conceptual complexity.

A differentiating factor between bvFTD and PNFA is that naming is disrupted for bvFTD whereas PNFA speakers show greater problems with verbs. bvFTD and SD might best be distinguished by a measure of fluency, considering the source of slowed speech: accessing the mental lexicon or an impaired discourse processing.

Differentiation of AD and bvFTD in the early stages is likely to be difficult on the basis of speech attributes alone and indeed misdiagnosis of bvFTD is also common on the basis symptoms other than speech related ones. As for bvFTD and SD, AD and SD might also best be distinguished on the basis of discourse processing limitations.

Conclusion

We offer here some insight into the difficulties of differentiation between the dementia subgroups based on their speech symptoms through our attempt to locate the impairments within the Levelt model of speech production. Within this framework, the differences, but also the similarities of symptoms become generally explicable, though ambiguities arising from the potential for errors to propagate through the model remain. The approach might be helpful in tandem with other diagnostic tools for avoiding misdiagnosis and adjusting the speech therapy for patients. In future, a targeted speech task (e.g. the HCRC map task (Anderson et al., 1991)) might be used to identify the impairments of a patient at an early stage of the disease, and to differentiate those related to the conceptual preparation from those due to grammatical encoding.

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Data Statement

No new data were created during this study.

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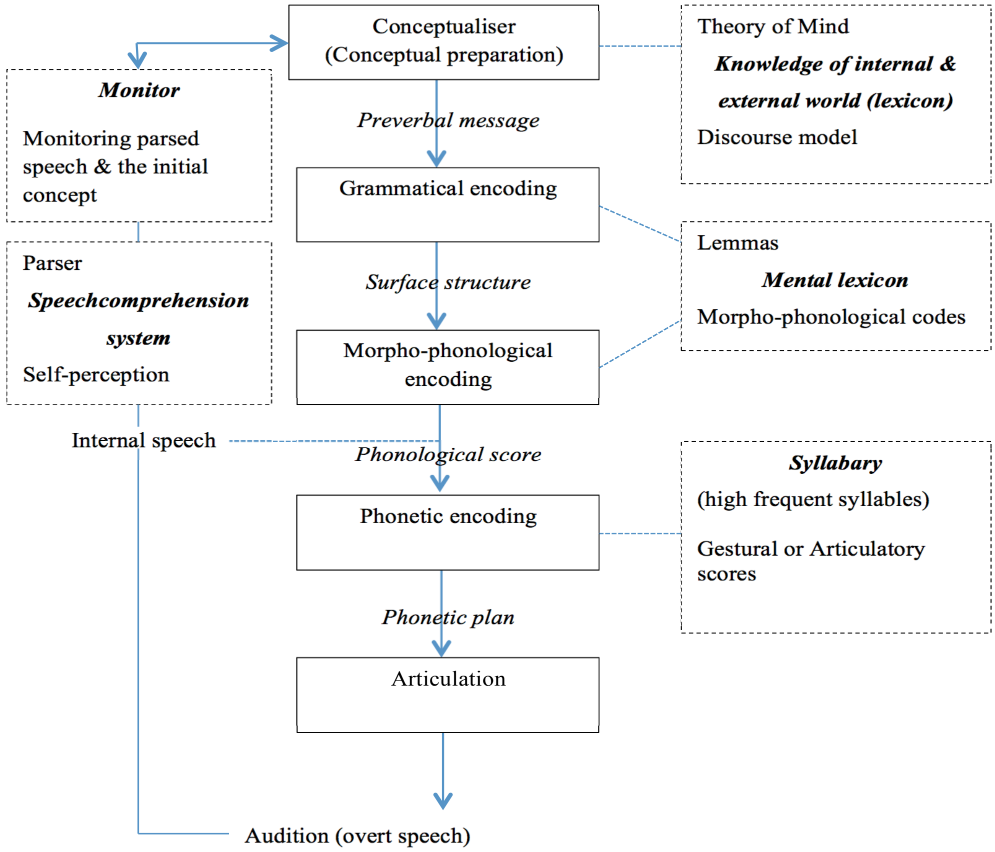
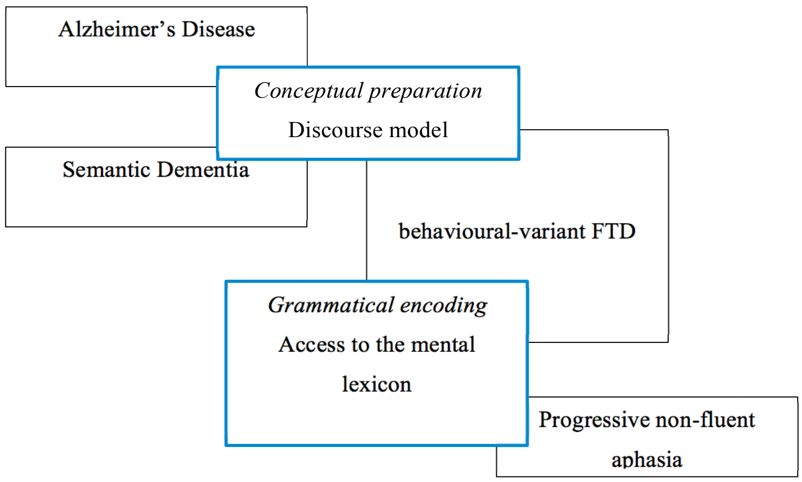
Figures

Figure 1.



The Levelt model adapted from Levelt (Levelt, 1992, 1999, 2001). Utterance preparation gets initiated by the conceptual preparation, and passes through the grammatical encoding, morpho-phonological encoding, and phonetic encoding before it can be articulated.

Figure 2.



Affiliation of speech impairments of the subgroups of dementia for conceptual preparation and grammatical encoding in the Levelt model.

Appendix B Protocol - Healthy Study

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Protocol

Study Title: Conversation Analysis and Turn Taking Behaviour

Researchers: Manuela Bung (PhD student),
Anna Barney (Supervisor),
Carl Verschuur (Supervisor)

Funder: University of Southampton

Background

This study will be regarded as a pilot study for a PhD project which is about speech analysis in dementia. We aim to prove our theory that turn taking features in natural conversation will exhibit differentiation or characterisation of speech behaviour in terms of familiarity and to achieve control data.
The PhD study's background is based on dementia research related to communication/speech:

Communication and understanding of words require a range of resources such as lexical, semantic and perceptual processing. The organization and interactions during a conversation depend on the ability to plan and to exchange information. These executive functions, such as structuring and organizing, may be impaired when brain networks are disrupted. Language processing is particularly disturbed when temporal and frontal cortical areas are affected. The subsequent abnormal breakdown in fluent speech can be observed in FTD or AD, in which brain atrophy in frontal and/or temporal area(s) is common. Recently, progress in research in clinical characteristics, neuroimaging and pathology has improved the understanding of the emergence, development and the different stages of speech performance in the progress of FTD and AD.
Interestingly, the ability to participate in spontaneous conversation is not often considered and not well studied in any dementia group though the loss of conversational skills significantly affects the quality of life of dementia patients.

We assume that turn taking characteristics, occurring in spontaneous speech, which indicate, for example, whether the current speaker will continue or whether the other person may speak, will be different between conversations with familiar and unfamiliar conversation partners.

Based on this background, we want to collect control data by using the same methodology as planned for the main study and prove if a familiarity effect exists.

Are turn taking characteristics, which indicate, for example, whether the current speaker will continue or whether the other person may speak different between conversations with familiar and unfamiliar conversation partners?

Method

Two natural conversation dialogues between i) a participant and their familiar interlocutor and ii) a participant and a less familiar person, will be audio recorded during 1 session. For eliciting conversation data, we will use a ‘map task’ as a tool to encourage spontaneous speech in which the participant firstly describes the map to the familiar person, and secondly describes to a less familiar person, how to get from a starting point to a finishing point on the map. Differences in the copies of the maps held by the two conversational partners in the task are significant and intended to result in a speech interaction (conversation). We will relieve possible pressure by pointing out that there is ‘no right or wrong’ answer in either task.

[13/11/2013] [V2]

We are not interested in the content of the conversation, but in the organization of conversational turn taking.

We will also use a questionnaire asking for name, date of birth, language background and speech/hearing impairment.

Materials
Audio recording devices
Video recording devices
Maps (paper sheet)
Questionnaire

Participants
Candidates are be required to be 18 years of age or older, so as to be able to give consent. It is emphasized in the information sheet that participation is voluntary. The researcher ensures and keeps in mind the best interest of the participants. The participant can take part during the study time period any time they want.

The sample size (40 people) calculated is the maximum estimated numbers of participants expected to be available during the time of the pilot study.

Inclusion criteria:
- first language is English/ or fluent English speaker
- participants must be over 18 years of age

Exclusion criteria:
- self-reported hearing impairment or self-reported cognitive speech impairment (e.g. aphasia, dysphasia following brain injury)

Flyers with information about the project and contact details will be posted mainly in the ISVR (Institute of Sound & Vibration, Building 13, Highfield Campus) to recruit students.
In case the flyers are not sufficient enough, lecturers of the ISVR will be contacted and asked to allocate 5 minutes of their lectures during arranged time slots to the researcher in order to inform and recruit students for an experiment ('Letter of Agreement' is attached).

Procedure
This will be a pilot study in which the participants are taking part for a maximum of 70 minutes (20 minutes: welcoming and explanation of the study, answering of any questions that may arise / 15 minutes: first speech task / 10 minutes: break / 15 minutes: second speech task/ 10 minutes: thanking for participating and their time, answering any questions that may arise) in each session.

A ‘map task’ in which the participant describes to a familiar person how to get from a starting to a finishing point on the map will be used. There will be deliberate differences in the copies of the maps held by the two conversational partners in the, for example: whereas the participant can see a tree in the right corner of the map, the map for their interlocutor has no tree printed in the right corner. After a 20 minutes introduction in which the study background and procedure will be explained, both participants will be asked to sit face to face on a table in a clinic room (ISVR). The participant will choose one map of the provided set of maps randomly and give the corresponding second map to their interlocutor. The audio recording equipment, set on the table between the conversation partners, and the video recording equipment, set in the corners of the room, will be turned on by the researcher to record the conversation for later processing. The researcher will not be in the room during the conversation but will be within earshot of the conversation in case of any

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problems or questions arising. After the conversation is finished, the recording will be ended by the researcher. The endpoint of the conversation is either achieved by finishing the route or by an indication of conversation running out such as silence or verbally note towards the researcher. Following the speech task, a 10 minutes break will be given in which the participants can move around, or go to the bathroom, as needed.

Second Speech task
A second map task will be used to record a conversation between the participant and a less familiar person. The participant will choose one map of the provided set of maps randomly and give the corresponding second map to a less familiar person. The procedure will be the same as for the first task. The researcher will not be present but will be within earshot of the conversation in case of any problems or questions arising. After the conversation is finished, the recording will be ended by the researcher. The endpoint of the conversation is either achieved by finishing the route or by an indication of conversation running out such as silence or verbally note towards the researcher.

Once the second speech task is completed, the participant and his/her interlocutor will be thanked and will be free to leave.

Statistical analysis

Correlational analysis of conversation parameters
Descriptive statistics regarding means and ranges of turn-taking analysis results
Evaluating the questionnaire's answers by calculating correlation with conversation/ turn taking parameters

Ethical issues
Loss of ability to give consent:
There is a possibility that probable participants are not able to give consent. If the researcher considers this with any participant, no data will be collected from that participant and their participation will be withdrawn.

Feeling obliged to participate:
It is emphasized in the Information Sheet that participation is voluntary.

Data protection and anonymity
Any documents containing identifying information shall be assigned a participant ID. All electronic information will be stored in secure, encrypted files on a password-protected computer. Hard copy will be archived for reference purposes, and stored in locked filling cabinets within a secure office environment.
There will be no disclosure of research information except to other authorised persons working on the project. Confidential information will only be shared with other people if the participant provides explicit consent.

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Participant Information Sheet

Study Title: Conversation Analysis and Turn Taking Behaviour

Researcher: Manuela Bung **Ethics number**: 8316

Please read this information carefully before deciding to take part in this research. If you are happy to participate you will be asked to sign a consent form.

What is the research about?
The purpose of this research is to find speech parameters which can characterise and describe the conversational interaction between a speaker and either a familiar or a less familiar interlocutor. This study will be regarded as a pilot study for a PhD project which is about speech analysis in dementia. We aim to prove our theory that turn taking (one person speaking at a time and the space in which one person stops talking and another begins) features in natural conversation will exhibit differentiation or characterisation of speech behaviour in terms of familiarity and to achieve control data.
We believe that there may be a relationship between how people talk and their general health. We think this may be particularly noticeable in people with certain forms of dementia. It is possible that some speech characteristics change over time and that this change could provide a simple way of assessing a person's progress.

What will happen to me if I take part?
If you decide to take part, you will be given an appointment time to meet the researcher Manuela Bung. The researcher will explain the study to you and answer any questions you may have. You will be asked to sign a Consent form. The researcher will then ask you a few questions about personal data (e.g. date of birth, speech/hearing impairments). You and your interlocutor in the conversation will then be asked to sit face to face at a table in a quiet room at the ISVR. On the table there will be a map and an audio recording device. A video equipment will be set in the corners of the room. The video recording is optional. You will be asked to talk about the map on the table. You will be asked to describe a journey you might take from one place on the map to another. The procedure will be carried out twice: once with a familiar conversational partner and once with a less known person. With your permission, this conversation will be audio and video (optional) recorded. If you have any questions during the session the researcher will always be on hand to answer questions or explain further.

The whole session will last about an hour.
There will be short breaks included during the session when you can move around, or go to the bathroom, as needed.
You can withdraw from the study at any time you want without giving a reason and without any impact on your legal rights.

Are there any benefits in my taking part?
This study may not have a direct benefit for you, but you may feel satisfaction in knowing that your participation in this study could help create knowledge that leads to improved treatment of people with dementia. However, you should be aware that positive benefits in the future cannot be guaranteed.

Are there any risks involved?
The study procedure does not involve any kind of treatment or intervention. We will try to make the situation as much comfortable as possible for you. If you feel

[13/11/2013] [V2]

uncomfortable at any time, the speech task would not proceed and you will be free to leave.

Will my participation be confidential?
There will be no disclosure of research information except to other authorised persons working on the project. Confidential information will only be shared with other people if you provide explicit consent.

What happens if I change my mind?
We firstly want to remind you that your participation in this study is completely voluntary and do not want you to feel obligated to participate if you are uncomfortable with the idea. Should you change your mind at any time before, or during, the study your rights will in no way be affected. If you do withdraw, we will need to use the data that has already been collected, so that we can analyse the results from the trial accurately.

What happens if something goes wrong?
If you have concerns about any aspect of this study, please contact Manuela Bung, mb4g12@soton.ac.uk. If you are still unhappy and wish to complain more formally, please contact: Martina Prude, Head of Research Governance for the University of Southampton (Phone: 02380 595058; email: mad4@soton.ac.uk. It is highly unlikely that you will be harmed during this study. If you are, however, you may have grounds for legal action against the University of Southampton.

Where can I get more information?
You may call the supervisor of the chief investigator, Anna Barney on 023 8059 3734, or email the chief investigator of this study, Manuela Bung, at mb4g12@soton.ac.uk, who can answer any question regarding information on this sheet, or queries about the study.

[13/11/2013] [V2]

St George's University of London — UNIVERSITY OF Southampton

CONSENT FORM (V2)

Study title: Conversation Analysis and Turn Taking Behaviour

Researcher name: Manuela Bung
Study reference:
Ethics reference: 8316

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

I have read and understood the information sheet (13/11/2013 (V2)) and have had the opportunity to ask questions about the study.	☐
I agree to take part in this research project and agree for my data to be used for the purpose of this study	☐
I understand my participation is voluntary and I may withdraw at any time without my legal rights being affected	☐
I agree to be video-recorded during the speech task (optional)	☐

Data Protection
I understand that information collected about me during my participation in this study will be stored on a password protected computer and that this information will only be used for the purpose of this study. All files containing any personal data will be made anonymous.

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

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

Date……………………………………………………………………………………………………..

[13/11/2013] [V2]

St George's University of London

UNIVERSITY OF Southampton

Questionnaire

Study: Conversation Analysis and Turn Taking Behaviour

Researcher: Manuela Bung

Ethics reference: 8316

Surname	Forename
Date of Birth	Gender [ ] female [ ] male
Native speaker (first language English) [ ] Yes	Non-native speaker (fluent in English) [ ] Yes First language: Second language:
Hearing/Speech Impairment? [ ] Yes: please specify [ ] No	

[09/052013] [V1]

Appendix C Protocol - Patient Study

Study Protocol

PhD Study Title:

TURN TAKING DURING CONVERSATIONAL INTERACTION IN ALZHEIMER'S DISEASE AND FRONTOTEMPORAL DEMENTIA

Chief Investigator **Manuela Bung**
PhD Student
Signal Processing & Control Group
Institute of Sound & Vibration
University of Southampton
Email: mb4g12@soton.ac.uk

Principal Investigator **Dr Anna Barney**
Associate Dean Education
University of Southampton
Tel: 023 8059 3734
Email: ab3@soton.ac.uk

Patient recruitment **Dr Peter Garrard**
Reader in Neurology
St George's University of London
Tel: 0208 725 2950
Email: pgarrard@sgul.ac.uk

[05/11/2013] [V3] [Reference: 13/LO/1301]

Signature Page and Statement

This protocol has been reviewed by the Chief Investigator and the Principal Investigator. The investigators agree to perform the investigations and to abide by this protocol.

1. **Chief Investigator**
   Manuela Bung
   PhD Student
   University of Southampton

   Signature: Date:

2. **Principal Investigator**
   Dr Anna Barney
   Associate Dean Education
   University of Southampton

   Signature: Date:

Contents

List of Abbreviations

AD	Alzheimer's disease
ACE-R	Addenbrooke's cognitive examination-revised
bvFTD	Behavioural-variant of frontotemporal dementia
CA	Conversation analysis
CIS	Carer Information Sheet
GP	General Practitioner
FTD	Frontotemporal dementia
PIS	Participant Information Sheet
PNFA	Progressive non-fluent aphasia
SD	Semantic dementia
SFS	Speech Filing System

In the following, the term 'carer' will be used and stands for 'familiar person' such as a relative, partner, close friend.

1 Synopsis

Full study title	Turn taking during conversational interaction in Alzheimer's disease and frontotemporal dementia
Chief Investigator	Manuela Bung (PGR)
Principal Investigator	Dr Anna Barney
Employer	University of Southampton
Disease under investigation	Alzheimer's disease (AD), frontotemporal dementia (FTD)
Study duration	2 years
Objective	To establish whether measures of turn-taking competence during speaking can describe and characterise AD and FTD at an early-onset of the disease
Study population	AD and FTD patients, their carers
Methodology	Speech task, questionnaire study
Study treatment and/or drugs (i.e. dose and mode of administration if applicable)	No drugs or other treatment are involved

2 Background and Purpose

The purpose of this research is to identify patterns of language use in conversational interactions that are characteristic of Alzheimer's disease (AD) and frontotemporal dementia (FTD) including its sub-groups: progressive non-fluent aphasia (PNFA), semantic dementia (SD) and behavioural-variant frontotemporal dementia (bvFTD). It is well known that all of these dementia groups show progressive as well as a range of other behaviours such as disinhibited, withdrawn or repetitive speech output. We hypothesise that features specific to conversational speech will reveal parameters that can differentiate the groups early in the onset of dementia.

Communicating and understanding words requires a wide range of cognitive resources involving phonological, lexical, semantic and perceptual processing. Disturbance in these domains is associated with pathology in temporal and/or frontal cortical areas. The subsequent abnormal breakdown in fluent speech can be observed in FTD or AD, in which brain atrophy in these areas is common. Organization and interaction during a conversation depend, additionally, on the ability to plan and exchange information (Peelle & Grossman 2008). Such executive resources are required for structuring, planning, monitoring and organizing speech output, and are impaired when critical networks in dorsolateral prefrontal brain regions become disrupted. Recently, progress in research in clinical characteristics, neuroimaging and pathology has improved the understanding of the emergence, development and the different stages of speech performance in the progress of FTD and AD.

Although the pure speech impairment of PNFA (agrammatic and dysfluent speech), SD (progressive language and cognitive deficits such as impaired comprehension of words and related semantic processing) and AD (spontaneous speech is highly affected claimed to be caused by “no-pre-emptive planning or memorization of a response” (Guinn & Habash 2012)) are well documented, language in bvFTD, with its symptoms of change in personality and social behaviour, “apathy and/or disinhibition, emotional blunting, stereotyped or ritualised behaviours, loss of empathy, alterations in appetite and food preference with limited or no insight” (Lillo & Hodges 2009, p.1131)) has been less extensively studied. Moreover, the ability to participle in spontaneous conversation is only rarely considered in any dementia group though the loss of conversational skills significantly affects the quality of life of dementia patients (Clare & Shakespeare 2004).

3 Hypotheses

We hypothesise that the different types of dementia can be characterised by their speech difficulties in conversation. In the context of conversation analysis, we predict that speech and language observations will be useful in the early stage of diagnosis and for disease progression monitoring. It is already shown in the literature that the FTD subgroups differ in discourse processing in several parameters (Peelle & Grossman 2008). However, studies of conversation analysis and narrative abilities in dementia speech are rare, and in particular longitudinal reports have not been carried out. Turn taking behaviour is not described in detail in the literature, though it is mentioned as a crucial factor to characterize the speech of dementia patients by some authors (Sabat 1991, Watson et al. 1998, Mikesell 2009).

We hypothesise that the turn taking features found in natural conversation will show differences between subgroups of dementia at an early stage of the disease. We assume the occurrence of difficulties in organization and planning of speech during the progress of dementia. Therefore, the organization of turn taking will cost more effort and result in a more considered and effortful fluent speech than the patient previously usually used (Ash et al. 2009).

We predict that turn taking characteristics, which indicate, for example, whether the current speaker will continue or whether the other person may speak, will be different between conversations with familiar and unfamiliar conversation partners. In the literature it is stated that for healthy subjects, difference concerning familiarity of conversation partner has no effect on the rate of dysfluency or on the frequency of violation of turn taking rules. Bortfeld et al. (2001) and Branigan et al. (1999) expected, for healthy subjects, more dysfluent speech with intimates because speakers are less anxious when speaking to a familiar addressee. Their results showed the opposite. Familiarity did not affect the dysfluency or turn taking behaviour in speech. The authors concluded that planning of speech or organization turn taking can be processed very quickly. This skill leads to the same dysfluency rate in healthy speech with familiar and unfamiliar people.

We though expect a familiarity effect in dementia speech: there is evidence that in a clinical environment, patients tend to conceal their speech difficulties with a less familiar person (e.g. GP) (Cohen & Conway 2007). Relatives often report that the patient is quite normal in the clinic but different otherwise

(Mikesell 2009). We assume that this appearance will result in a more dysfluent speech with a familiar person than with a less familiar person.

The possibility of an effect of familiarity with the conversation partner in dementia groups on speech and language patterns, especially in FTD, has not been fully explored. It has been noted that social interaction should be included in a conversational approach (Clare & Shakespeare 2004), but research literature in the context of AD and FTD diagnosis is limited. The exploration of the effect of familiarity with the conversation partner in FTD and AD could, however, be useful for a characterisation of the speech patterns of those groups and could therefore be advantageous to consider when developing criteria for diagnosis and monitoring.

Additionally, appropriate guidelines could help to improve inter-speaker attitudes and reduce distress in conversation especially between the patient and a familiar person, independent of dementia group.

4 Procedures

The experimental tasks require participants to give verbal responses to visual stimuli and do not involve any form of medical testing or intervention.

Two natural conversation dialogues between a participant and i) a familiar person (e.g. their partner, carer or relative) and ii) a less familiar person (a student or research assistant of St. George's Hospital) will be audio and video recorded during 3 sessions spread over a time period of 2 years. For eliciting conversation data, we will use a 'map task' (see Appendix A) in which one participant explains to the other how to get from a starting point to a finishing point on the map; differences in the copies of the maps held by the two conversational partners in the task normally give rise to a conversation between the participants.

We chose the map task for eliciting data because it is a natural stimulus for starting spontaneous conversation and has been previously used by Koiso et al. (1998) for analysing turn taking and backchannels on prosodic and syntactic features in spontaneous dialogues. As we are interested in change of speech patterns, it is not relevant whether the conversation topic remains the map or digresses. Indeed, it is expected that the patient and a familiar partner would be likely to diverge from the task and talk about other topics, as the disease progresses.

The procedure will take place in a quiet clinical room in St. George's Hospital in London. The researcher will not be in the room, but will remain within reach in case of any problems or questions arising. We are not interested in the content of the conversations, but in the organization of conversational turn taking. In any dissemination of the research, only short anonymised extracts from transcription of the conversation will be presented, after prior permission has been granted. We will record the participant and their carer at a time when they have a scheduled appointment for a routine consultation with their neurologist or nurse, in order to avoid the need for a special trip to the hospital. It will be made clear that the participant or their carer can withdraw from the study at any time they want without giving a reason and without it affecting their current or future health care.

5 Research questions

(1) Can conversational turn taking analysis be used to characterise different dementia patient groups such as Alzheimer's disease and frontotemporal lobe dementia and its subgroups at different stages of the disease?

(2) Does conversation analysis show an effect of member familiarity in Alzheimer's disease and frontotemporal lobe dementia?

6 Potential outcomes

Differentiation and characterisation of AD and FTD group

(1) Start of the experiment (early onset of dementia):
If CA and turn taking units are **not able** to describe and differentiate AD and FTD (subgroups), these features may successful later on in the progress of the disease.
If CA and turn taking units are **able** to differentiate and describe AD and FTD (subgroups), they can be considered as parameters for future diagnostic methods.

(2) Middle or end of the experiment:
If CA and turn taking units are **not able**, at any point of the disease, to differentiate or characterise AD and FTD (subgroups), it can be concluded that the chosen parameters are not helpful in diagnosis.
If CA and turn taking units are (still) **able** to differentiate and describe AD and FTD (subgroups), the distinguishing parameters may be helpful for future diagnostic methods.

Familiarity effect

(3) Start to middle to end of the experiment:
IF CA and turn taking units are **not able** to differentiate the speech behaviour between patient/carer and patient/less familiar person at any point of the experiment period, the parameters cannot be said to support a familiarity effect.
If CA and turn taking units are **able** to differentiate the speech behaviour between patient/carer and patient/less familiar person at any point of the experiment period, the successful parameters show a familiarity effect.

7 Method

Study design

This will be a longitudinal study with patients and their carers taking part for a maximum of 70 minutes (20 minutes: welcoming and explanation of the study, recording of the necessary patient information, answering of any questions that may arise / 15 minutes: first speech task / 10 minutes: break / 15 minutes: second speech task, answering the questionnaire by the carer / 10 minutes: thanking the patient and their carer for participating and their time, answering any questions that may arise) in each session.

Sessions will be repeated at intervals of approximately 6-9 months over a period of 2 years. Participants will be recorded taking part in an undirected spontaneous dialogue elicited using a standardised task protocol, administered at the end of a routine follow-up visit to the cognitive neurology clinic where their condition is clinically monitored and managed.

Informed consent (see Appendix B) will be obtained from patients and their carers before each recording session. Eligible participants will be patients in whom a diagnosis of AD or FTD has been made, and their carers. Patients will be recorded during performance of the conversation task with the carer, and with a less familiar person (in this case a student or research assistant).
Additionally, the carers will be asked to complete a questionnaire (see Appendix C) on each occasion about speech and language changes they have observed in the patient.

Setting
The recordings will take place in a quiet clinical room in St. George's Hospital, London.

Participants
Patients with a diagnosis of AD, PNFA, SD or bvFTD, made within the previous two years by a neurologist, who are able to understand the nature and purpose of the study and consent to participate. The patients' regular carers will be the interlocutors and therefore be part of this study. Their carers will also be asked to give consent for their own participation.

It is important to note that the research team will have access to pre-existing clinical evaluations such as the result of the Addenbrooke's cognitive examination-revised (ACE-R) and to other clinical information relevant to the study (see Appendix D).

Inclusion/Exclusion criteria
Inclusion
Patients will be invited to participate if they fulfil the following criteria:

- They carry a diagnosis of AD or PNFA, SD or bvFTD, made by a neurologist
- They are at a sufficiently early stage of disease at point of joining the study, 6 months after diagnosis was made
- They are willing and motivated to take part in the research
- They communicate in English

Carers should fulfil the following criteria:

- They should have a sufficiently close relationship to the patient (family member, regular caretaker) to be able to complete a questionnaire concerning changes to the patient's speech.

- They should be cognitively unimpaired and in good general health

Exclusion (patients and carers)

- Any medication (e.g. sedative drugs such as Benzodiazepines), which may exert an adverse effect on attention or concentration to an extent that would be detrimental to performance of the task.
- No (additional) neurological brain impairment which influences speech behaviour (e.g. brain tumour)

Sample size

This is a pilot study seeking to explore and document any speech differences observed between the groups, and to gather preliminary data on which to base power calculations for a larger study. We are, therefore, not planning to test statistically a specific hypothesis at this stage, but are recruiting a convenience sample of 10 subjects with AD and another 10 with behavioural variant FTD, with the aim of documenting and quantifying any differences that are apparent from the task of interest between these two groups, and between patients with dementia and normal controls (in this case, their carers).

Recruitment of participants

Patients with an AD or FTD diagnosis will be assessed by their neurologist for eligibility at St. George's Hospital during the time period of the experiment. If the patient meets inclusion criteria, the patient and their carer will be informed of the opportunity to participate in the study.

If they express interest, an information pack containing an invitation letter (see Appendix E) from the researcher and a Patient (PIS) and a Carer Information Sheet (CIS) (see Appendix F) will be handed to them together with a postage-paid envelope.
If the patient and their carer are willing to participate, they will complete a reply slip and return it to the researcher in the envelope provided. Once individuals with dementia have decided to participate, their general practitioners (GP) will be informed of their participation. Consent to contact the participants' GPs for this purpose will also be sought (see Appendix G).

Potential participants will be informed of the date and time of the data collection appointment, which will coincide with their next routine clinic visit to St. George's Hospital, London. The researcher will schedule this initial invitation at an appropriate point in the clinical consultation. At this time they will have the opportunity to ask further questions about the study.

The researcher will ask then the participant and their carer for information about the condition and capacity of the participant. At the first appointment, the participant and carer will be asked to sign consent forms. At each subsequent visit the researcher will collect information about the participant's language and behavioural symptoms using a standardised questionnaire.
A consultant neurologist, Dr Peter Garrard, who has undertaken extensive and regular training in clinical assessment as part of his required continuing professional development and who works regularly with

patients with diseases causing progressive neurological impairment, will assess the capacity of the patient to undertake the tasks of the study on each visit.
In the event of loss of capacity the following steps will be taken to offer further protection to participants:

- The neurologist Dr Peter Garrard will be consulted about their continued involvement in the project
- The participant's best interests will outweigh those of the research project
- If the participant indicates (in any way) that s/he wishes to be withdrawn from the project s/he will be withdrawn without delay.

Equipment
For recording speech:
Audio/video-recording device

Material for speech task:
Pictures (Map) printed on a paper sheet

Questionnaires

Data collection procedure
The researcher will answer any questions which may arise. Both, the participant and their partner will be informed that they are free to withdraw from the recording session at any time they want without giving a reason and without it affecting their current or future health care.
After consent forms (Appendix B) have been signed, the researcher will start the experiment procedure. The consent form has to be signed at each session by both, the patient and their carer.

Speech tasks
Two natural conversation dialogues between i) a participant and their carer and ii) a participant and a less familiar person (here a student or research assistant), will be audio and video recorded during 4 sessions spread over a time period of 2 years.
We are not interested in the content of the conversation, but in the organization of conversational turn taking.
We will relieve possible pressure by pointing out that there is 'no right or wrong' answer in either task.

First speech task

A 'map task' in which the participant describes to the carer how to get from a starting to a finishing point on the map will be used. There are deliberate differences in the copies of the maps held by the two conversational partners, for example: whereas one participant sees a van in the bottom left corner of the map, the map for the other participant has no van printed there.

After a 20 minutes introduction in which the study background and procedure will be explained, both participants will be asked to sit face to face at a table. The patient will choose one map randomly from the set of maps and give the corresponding second map to the conversational partner. The audio recording equipment, set on the table between the conversation partners, and the video recording equipment, set in the corners of the room, will be turned on by the researcher to record the conversation for later processing. The researcher will not be in the room during the conversation but will be within earshot of the participants in case of any problems or questions arising. After the conversation is finished, the recording equipment will be switched off by the researcher. The endpoint of the conversation is achieved either by finishing the task or by an indication of conversation running out such as long silence or call for the researcher to return. Following the speech task, a 10 minutes break will be given in which the participants can move around, go to the bathroom etc., as needed.

Second Speech task

A second map task will be used to record a conversation between the participant and a less familiar person, such as a student or research assistant. The patient will choose randomly from the remaining set of maps and give the corresponding second map to the student or research assistant. The procedure will be the same as for the first task. The patient's partner will not be present but will be within earshot of the participants in case of any problems or questions arising. After the conversation is finished, the recording device will be switched off by the researcher. The endpoint of the conversation is either achieved by finishing the route or by an indication of conversation running out such as silence or a verbal indication from the patient to the researcher.

Questionnaire

Following the map task, the patient's partner will be asked to complete a questionnaire regarding any speech changes noticed in the participant. The questionnaire will include questions about speech changes and speech differences during the 'map task' and in daily life. The partner will have time to answer the questions while the second 'map task' is taking place.

Once the second speech task and questionnaire are completed, the participant and carer will be thanked and will be free to leave. They will be given the date for their next appointment, which will coincide with their next appointment at the clinic, and a reminder will be sent out 14 days before they are due to attend.

Data analysis

The conversation between the participants will be audio recorded with a digital recording device and after the session transferred and stored as a .wav file on a password protected computer. Analysis will use 'Praat', a free software for speech analysis and the free software 'SFS' (Speech Filing System), developed at University College London, which will be used for an automatic word/utterance detection and segmentation. All conversations will be manually evaluated by the researcher listening through headphones. Additionally, we will video record the interlocutors during their conversation to monitor non-verbal back-channelling (visual cues used to indicate turn taking information).

The audio and video recordings will be transferred after the session and stored on a password protected computer. The video material will be evaluated visually in the first instance to identify turn taking cues and their timing in relation to speech events. More automated image processing methods may also be used to track motion and identify relevant gestures and timings.

Conversation analysis (CA) techniques described below will be used to mark the linguistic changes in each group over time and inter-group linguistic differences in order to develop a profile of language change across subject groups. We will also consider the speech and language changes over time within individuals. The lack of literature concerning turn taking analysis in dementia requires us to adopt analysis measures which have been validated by several CA and turn taking researchers for healthy and other kinds of impaired speech such as semantic-pragmatic disorder (Adams and Bishop 1989, Ford and Thompson 1996, Cowley 1998). We will evaluate the applicability of these measures to dementia speech during the study and make recommendations about their suitability for future use with these patient groups.

The following 'Units of Exchange' will be used to analyse the turn-taking behaviour of the participants:

(a) Initiation unit: a parameter that measures the correct initiation (through syntactic, intonational and pragmatics completion) (Adams and Bishop 1989).

(a.1) Suprasegmental units:

I. Quantity

- a parameter that measures the duration of a segment (word/utterance)

II. Intensity

- a parameter that measures accentuation and stress of a segment (word/utterance)

III. Intonation

- a parameter that measures the speech melody of a segment (word/utterance)

(b) Turn-taking infringement: a parameter that measures gaps or violations in response to turn-taking cues which are described in (a).

(c) Repair: a parameter that measures the ability of both, speaker and interlocutor, to recognize an inappropriate utterance and how to correct it (using confirmation, clarification, self-repair, need of repair-support by the listener)

(d) Cohesion unit: a parameter that measures the correct use of references and ellipsis ("[...] use pronouns and demonstratives which are not interpreted semantically in their own right, but make reference to an element from another utterance for their interpretation [...]", Adams and Bishop 1989, p.219)

(e) Non-verbal backchanneling: parameters that provide information about turn taking organization in non-verbal communication.

The parameters (b), (c), (d) and (e) will be used to verify a potential familiarity effect.

Statistical tests:
Correlational analysis of 'Units of Exchange' results (a-e) with familiarity, patient group and stage of disease will be carried out to define inter-group speech behaviour and characteristics to investigate research question (1).
Descriptive statistics regarding means and ranges of turn-taking analysis parameters (a-e).
Evaluating answers to the questionnaire by calculating correlation with 'Units of Exchange' parameters (a-e).

8 Anonymity and storage of data
Every effort will be made to keep all information about the participants private. To protect the identity of the data, the participants will be assigned a unique number which with all data will be coded in the study database.
If one of the participants do withdraw from this study, the information s/he has already provided will be kept confidential.
All electronic information will be stored in secure, encrypted files on a password-protected computer for 10 years. Hard copy will be archived for reference purposes, and stored in locked filling cabinets within a secure office environment at the University of Southampton. After 10 years, all hard copies and speech recordings will be manually deleted.

Literature

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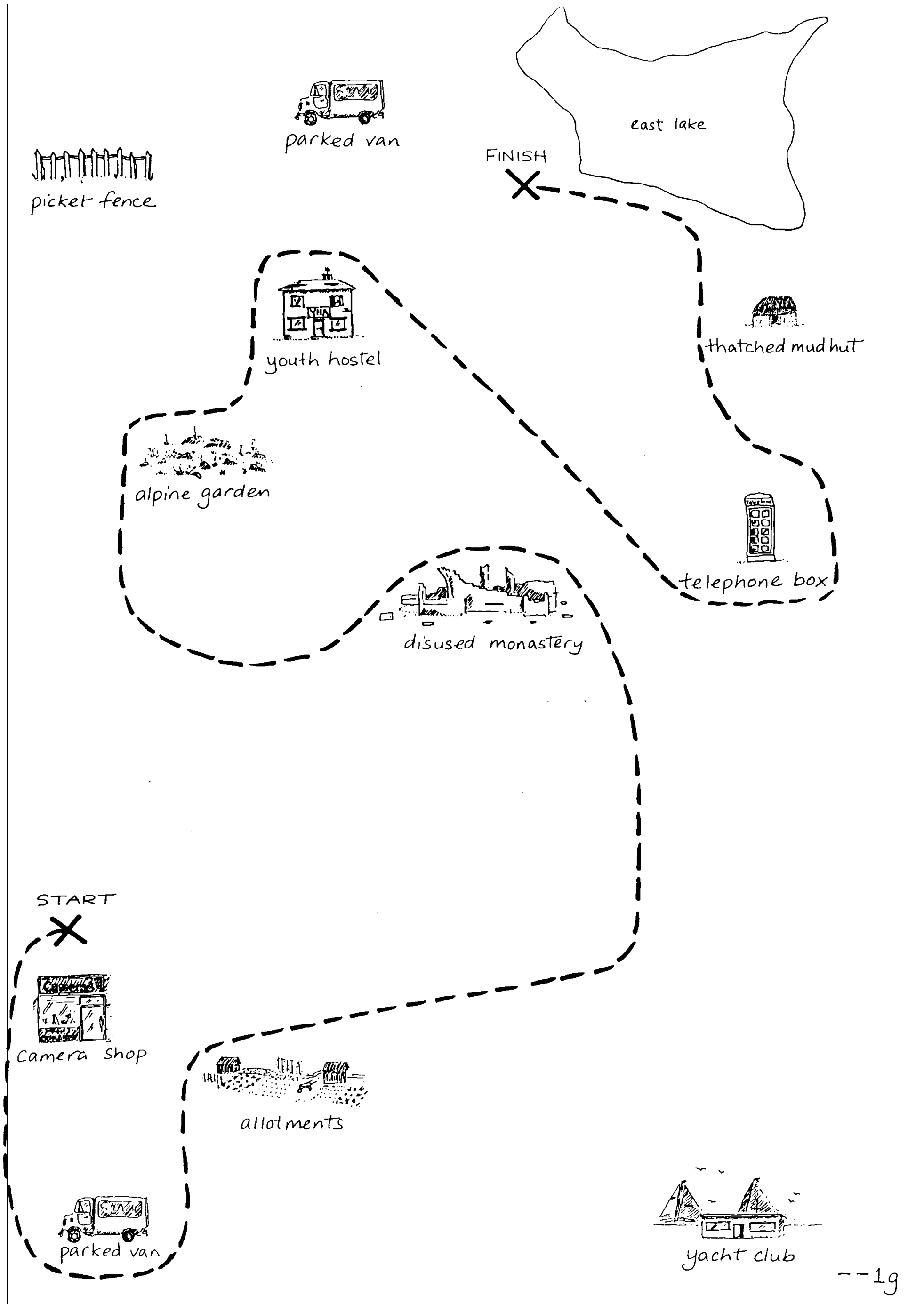
Appendix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parked van
picket fence
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alpine garden
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disused monastery
START
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allotments
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yacht club
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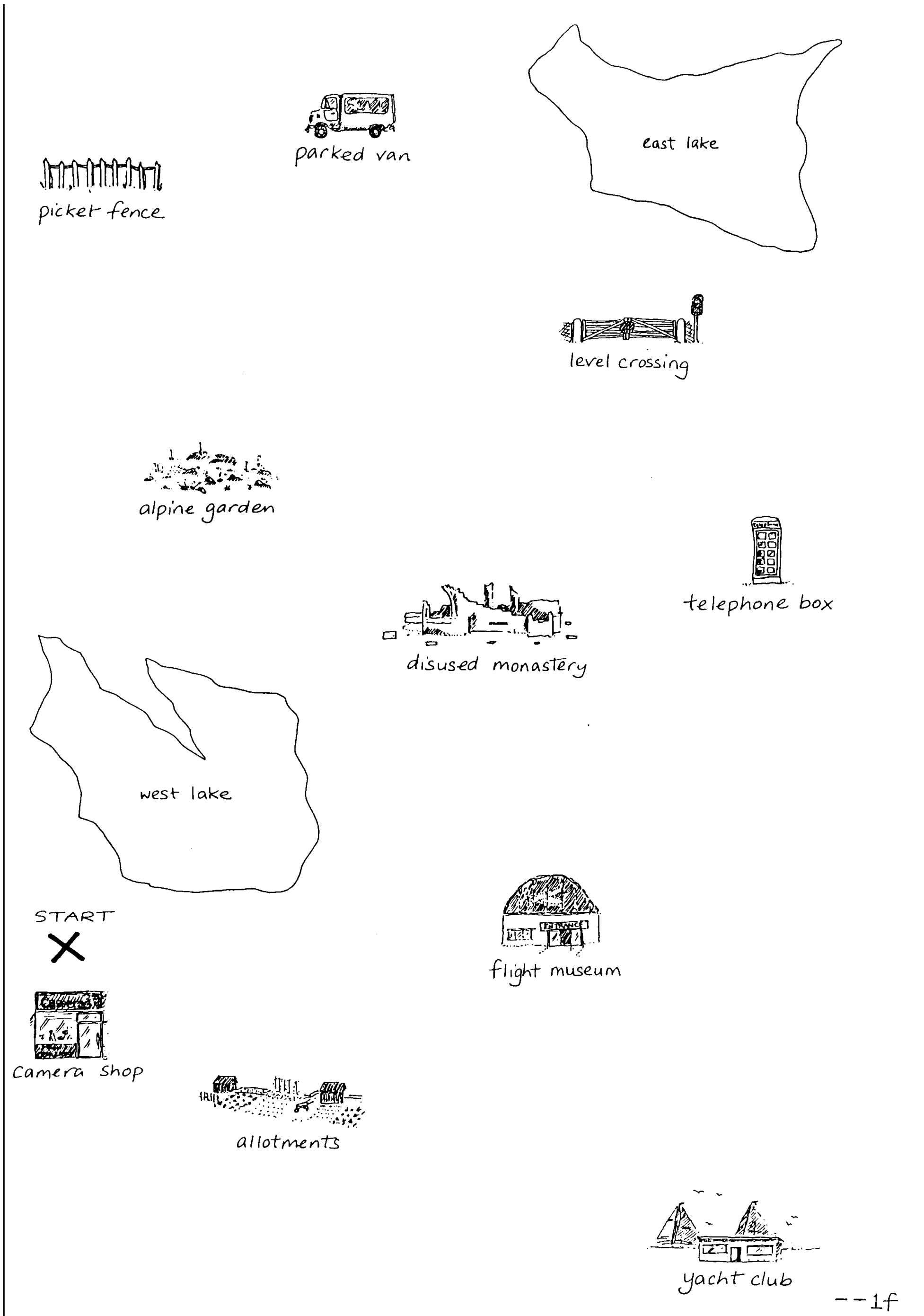
Map 0g


parked van
east lake
picket fence
level crossing
alpine garden
telephone box
disused monastery
west lake
START
flight museum
camera shop
allotments
yacht club
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Map 0f

St George's Healthcare NHS Trust

UNIVERSITY OF Southampton

Study number: 13/LO/1301
Patient Identification Number:

Consent Sheet

Title of PhD Project: Conversational interaction in dementia
Name of the Researcher: Manuela Bung
Contact: mb4g12@soton.ac.uk

Please initial box

1. I confirm that I have read and understand the information sheet dated 05/11/2013 (V3) for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my medical care or legal rights being affected. ☐

3. I understand that relevant sections of my medical notes and data collected during the study, may be looked at by individuals from the University of Southampton, from regulatory authorities or from the NHS Trust, where it is relevant to my taking part in this research. I give permission for these individuals to have access to my records. ☐

4. I agree that the recordings and the information gathered about me can be stored by the University of Southampton for 10 years, as described in the attached *Information Sheet*. All information and videos will be destroyed as well as speech recordings which will be electronically deleted after 10 years of storage. ☐

5. I agree to my GP being informed of my participation in the study. ☐

6. I agree to be video-recorded during the speech task (optional). ☐

Engineering and the Environment, University of Southampton, Highfield Campus, Southampton SO17 1BJ United Kingdom.
Tel: +44 (0)23 8059 5000 Fax: +44 (0)23 8059 3190 www.southampton.ac.uk/engineering

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7. I agree to take part in the above study. ☐

Data protection

I understand that information collected about me during my participation in this study will be stored on a password protected computer and that this information will only be used for the purpose of this study. All files containing any personal data will be made anonymous.

Name of Patient	Date	Signature

Name of Person taking consent	Date	Signature

When completed: 1 for participant; 1 for researcher site file; 1 (original) to be kept in medical notes.

Engineering and the Environment, University of Southampton, Highfield Campus, Southampton SO17 1BJ United Kingdom.
Tel: +44 (0)23 8059 5000 Fax: +44 (0)23 8059 3190 www.southampton.ac.uk/engineering

Study number: 13/LO/1301

Participant Identification Number:

Consent Sheet

Title of PhD Project: Conversational interaction in dementia

Name of the Researcher: Manuela Bung

Contact: mb4g12@soton.ac.uk

Please initial box

1. I confirm that I have read and understand the information sheet dated 08/10/2013 (V2) for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my medical care or legal rights being affected. ☐

3. I agree that the recordings and the information gathered about me can be stored by the University of Southampton for 10 years, as described in the attached *Information Sheet*. All information and videos will be destroyed as well as speech recordings which will be electronically deleted after 10 years of storage. ☐

4. I agree to be video-recorded during the speech task (optional). ☐

5. I agree to take part in the above study. ☐

Data protection

I understand that information collected about me during my participation in this study will be stored on a password protected computer and that this information will only be used for the purpose of this study. All files containing any personal data will be made anonymous.

Name of Participant Date Signature

When completed: 1 for participant; 1 for researcher site file; 1 (original) to be kept in medical notes.

[08/10/2013] [V2] [Reference: 13/LO/1301]

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Questionnaire I

Please read the questions below carefully and answer by ticking a box or writing a comment.

First name
Surname
Partner of

Today's conversation

Did you feel comfortable during the conversation with your partner?	Yes, I felt comfortable	No, I felt uncomfortable
If you felt uncomfortable, why? [e.g. environment, behaviour of your partner, low motivation, etc.]		
Do you think that the speech behaviour of your partner today differed from the speech s/he usually uses (at home)?	Yes, I've recognized a difference in her/his speech behaviour	No, I didn't recognize a difference in her/his speech behaviour
If you recognized speech differences, what differs? [e.g. pronunciation, use of more/less complex words, more/less interruptions, speed of speech (slower/faster)]		

[08/10/2013] [V2] [Reference: 13/LO/1301] 1
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Daily life's conversation

Do you recognize speech or language changes in your partner since the diagnosis?	Yes, her/his speech behaviour changed	No, her/his behaviour didn't change
If you recognized changes in the speech behaviour of your partner, can you describe these changes? [e.g. Slightly/striking changes in speech, pronunciation, use of more/less complex words, more/less interruptions, speed of speech (slower/faster) , forgetting words, repeating phrases]		
How do you perceive conversations with your partner in general?	The conversations are mostly not stressful and flow smoothly, like before the diagnosis	The conversations don't flow smoothly sometimes
If conversations don't flow smoothly sometimes, what are the reasons? [Multiple responses allowed. Tick all that apply.]	I have to repeat what I say	I have to explain what I mean or use different words
	I don't get appropriate answers/responses	I have to clarify/ correct what my partner says when s/he talks to others
	I have to ask questions to understand what my partner wants to say	I have to support my partner by offering answers because s/he has word finding difficulties
	My partner doesn't let me finish my sentence/ what I have to say/ interrupts me more than s/he used.	Other reasons:

2

[08/10/2013] [V2] [Reference: 13/LO/1301]
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Questionnaire II

Please read the questions below carefully and answer by ticking a box or writing a comment.

First name
Surname
Partner of

Today's conversation

Did you feel comfortable during the conversation with your partner?	Yes, I felt comfortable	No, I felt uncomfortable
If you felt uncomfortable, why? [e.g. environment, behaviour of your partner, low motivation, etc.]		
Do you think that the speech behaviour of your partner today differed from the speech s/he usually uses (at home)?	Yes, I've recognized a difference in her/his speech behaviour	No, I didn't recognize a difference in her/his speech behaviour
If you recognized speech differences, what differs? [e.g. pronunciation, use of more/less complex words, more/less interruptions, speed of speech (slower/faster)]		

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Daily life's conversation

Do you recognize speech or language changes in your partner since the last recording session?	Yes, her/his speech behaviour changed	No, her/his behaviour didn't change
If you recognized changes in the speech behaviour of your partner, can you describe these changes? [e.g. Slightly/striking changes in speech, pronunciation, use of more/less complex words, more/less interruptions, speed of speech (slower/faster) , forgetting words, repeating phrases]		
How do you perceive conversations with your partner in general?	The conversations are mostly not stressful and flow smoothly, like before the diagnosis	The conversations don't flow smoothly sometimes
If conversations don't flow smoothly sometimes, what are the reasons? [Multiple responses allowed. Tick all that apply.]	I have to repeat what I say	I have to explain what I mean or use different words
	I don't get appropriate answers/responses	I have to clarify/ correct what my partner says when s/he talks to others
	I have to ask questions to understand what my partner wants to say	I have to support my partner by offering answers because s/he has word finding difficulties
	My partner doesn't let me finish my sentence/ what I have to say/ interrupts me more than s/he used.	Other reasons:

[08/10/2013] [V2] [Reference: 13/LO/1301]
PhD study
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Tel: +44 (0)23 8059 5000 Fax: +44 (0)23 8059 3190 www.southampton.ac.uk/engineering

Patient Documentation Sheet (PDS)

First Name	
Surname	
Date of Birth	
Educational Level	
Relationship Between Patient And Control Duration	
Addenbrooke's cognitive examination-revised (ACE-R) Result	
Dementia Disease (AD or FTD)	
Date of Diagnosis	
Medication	

[08/10/2013] [V2] [Reference: 13/LO/1301]
PhD study
Engineering and the Environment, University of Southampton, Highfield Campus, Southampton SO17 1BJ United Kingdom.
Tel: +44 (0)23 8059 5000 Fax: +44 (0)23 8059 3190 www.southampton.ac.uk/engineering

Recipients address

Blackshaw Road
Tooting
London
SW17 0QT
Reception: 020 8672 1255

[Insert Date]

Dear [Recipient Name],

I am writing on behalf of the University of Southampton and St. George's Medical School, University of London to ask you to consider taking part in a PhD research study exploring the links between health status and speech. We are interested in the effects that the early stages of neurodegenerative conditions may have on people's participation in conversations. You are being invited because you have been diagnosed a neurodegenerative condition, and the clinical team of St. George's Hospital has advised that you are eligible to take part.

If you agree to take part, we will audio and video (optional) record two conversations: one between you and someone you knows well; and the other with a member of the research team. We may ask you to take part in the same procedure again after an interval of around 12 months. The recording sessions would take place following a routine visit to your neurologist or specialist nurse at the St. George's Hospital cognitive neurology clinic.

We hope to recruit 20 people with similar health problems will take part in the study. If you do not wish to take part in the study your decision will not in any way affect your treatment, now or in the future.

I enclose two copies of the Participant Information Sheet (PIS), for you and someone who knows you well, which provide more detailed information about the study, including what will happen during the study if you and your partner choose to take part.

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Tel: +44 (0)23 8059 5000 Fax: +44 (0)23 8059 3190 www.southampton.ac.uk/engineering

If you are interested in taking part, please complete and return the reply slip below using the stamped addressed envelope enclosed in the information pack. Alternatively you can email me on mb4g12@soton.ac.uk or telephone 023 8059 3734. If you have any questions you would like to ask to help you decide please contact me using any of the details above.

I appreciate your time in reading the information and considering whether to take part in this research.

Yours sincerely,

Manuela Bung
Postgraduate Research Student at ISVR, University of Southampton

✂---

I have read the Participant Information Sheet and I would like to take part in this study.
I agree that my GP will get informed about my participation in the study.
I understand that a member of the clinic team will give Manuela Bung (researcher) the date of my appointment. I am aware of her attendance at my next consultation at the St. George's Hospital, London.

Signature ______________________________ Date ______________

St George's Healthcare NHS Trust

UNIVERSITY OF Southampton

Participant Information Sheet (Patient)

Title of PhD project: **Conversational interaction in dementia**

Researcher name: Manuela Bung

Contact: mb4g12@soton.ac.uk

We'd like to invite you to take part in our research study. Joining the study is entirely up to you and before you decide we would like you to understand why the research is being done and what it would involve for you. Please feel free to talk to others about the study if you wish.

The first part of the Participant Information Sheet tells you the purpose of the study and what will happen to you if you take part.

Then we give you more detailed information about the conduct of the study.

Do ask us if there is anything that is not clear.

Please read this information carefully before deciding whether or not to take part in this research.

Who is organizing and funding the study?

The study is being organized by Manuela Bung (PhD student) and her supervisory team (Dr Anna Barney, Prof Carl Verschuur) at the University of Southampton (Engineering and the Environment, University of Southampton, Highfield Campus, Southampton SO17 1BJ United Kingdom).

The University of Southampton is the sponsor for this study and has overall responsibility for the study.

What is the research about?

We believe that there may be a relationship between how people talk and their general health. We think this may be particularly noticeable in people with certain forms of dementia. It is possible that some speech characteristics change over time and that this change could provide a simple way of assessing the progress of a person's disease.

Why have I been chosen?

You have been chosen because you have been diagnosed with a form of dementia. The clinical team at St. George's Hospital has recommended that you are suitable to take part in this study.

Do I have to take part?

No, it is up to you to decide whether or not to take part in this study. If you do decide to take part, you should keep this information sheet, complete the enclosed return slip (see your invitation letter) and send it to the research team on the envelope provided.
If you do not want to take part you do not need to do anything.
Whether or not you choose to take part will not affect your medical care in any way.

Why is it necessary for a relative/partner/close friend to take part as well?

Your partner in the research may be a close friend or a relative who knows you well, or a person who shares your daily activities. It is important that this person is able to come with you. We will want to ask this person some questions about your speech, from their viewpoint.

What will happen to me if I take part?

If you decide to take part, you will be given an appointment time to meet the researcher Manuela Bung. This will be on the same day as one of your routine clinic visits to St. George's Hospital. The researcher will explain the study to you again, and answer any questions you or your partner may have. You and your partner will then be asked to sign a consent form.
You and your partner in the conversation will then be asked to sit face to face at a table in a quiet room at St. George's Hospital. On the table there will be a map and an audio recording device. There will be also video recording devices in the corners of the room, recording your expressions and gestures. You will be asked to talk about the map on the table. You will be asked to describe a journey you might take from one place on the map to another. The procedure will be carried out twice: once with your familiar conversational partner and once with a student or research assistant of St. George's Hospital. We would like to record you on up to 4 occasions (each recording session will take place after your regular clinic visit at St. George's Hospital). With your permission, this conversation will be audio- and video recorded. If you prefer not to be video recorded you can still take part in this study. If you have any questions during the session the researcher will always be on hand to explain further.

The whole session will last about an hour.

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There will be short breaks included during the session when you can move around, or go to the bathroom, as needed.
You and your partner can withdraw from the study at any time you want without giving a reason and without any impact on your current or future clinical care.

Are there any benefits in my taking part?

This study may not have a direct benefit for you, but you may feel satisfaction in knowing that your participation in this study could help create knowledge that leads to improved treatment of people with similar conditions to yours. However, you should be aware that positive benefits in the future cannot be guaranteed.

Are there any risks involved?

The study procedure does not involve any kind of treatment or intervention. We will try to make the situation as comfortable as possible for you and your partner. If you feel uncomfortable at any time, the speech task would not proceed and you will be free to leave.

Will my participation be confidential?

We would like to inform your GP about you participating in this study by sending him or her a letter with a brief description about the project if you give us the permission to do.
Every effort will be made to keep all information about you private. To protect the identity of your data, you will be assigned a unique number which with your data will be coded in the study database.
If you take part, it will be necessary for qualified members, individuals from the University of Southampton, from regulatory authorities or from the NHS Trust to have access to your medical records, where it is relevant to your taking part in this research.
By signing the consent form, you are giving permission for this to happen. If you decide to take part in this research study, your authorisation for this study will not expire unless you revoke it.
If you do withdraw from this study, the information you have already provided will be kept confidential.
It is your right to obtain information on what information is recorded about you and request corrections of errors.

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Your ability to consent.

You must have the ability to give informed consent in order to participate in this study at your first appointment. By this we mean that you fully understand what the study is about and what will happen to you during the study whilst you are taking part.

If your condition deteriorates and you are no longer able to give consent during the study, Dr Peter Garrard (neurologist at St. George's Hospital London) will be asked to advise on your current condition and capacity to continue with the study. Dr Peter Garrard has undertaken extensive and regular training in clinical assessment as part of his continuing professional development. If he advises against your continuing, you will be withdrawn from the study. Also, if you indicate (in any way) that you wish to be withdrawn from the project you will be withdrawn without delay.

We will make sure that your interest will outweigh those of the research project.

What will happen if I don't want to carry on with the study?

We firstly want to remind you that your participation in this study is completely voluntary and do not want you to feel obligated to participate if you are uncomfortable with the idea. Should you change your mind at any time before, or during the study your rights or the health care service being provided will in no way be affected. If you do withdraw, we will need to use the data that has already been collected, so that we can analyse the results from the trial accurately.

What if something goes wrong?

If you have concerns about any aspect of this study, please contact Manuela Bung, mb4g12@soton.ac.uk. If you are still unhappy and wish to complain more formally, please contact: Martina Prude, Head of Research Governance for the University of Southampton (Phone: 02380 595058; email: mad4@soton.ac.uk); or, alternatively, through the normal NHS complaints procedure (details available from your GP surgery). It is highly unlikely that you will be harmed during this study. If you are, however, you may have grounds for legal action against the University of Southampton and the NHS.

What will happen to the results of this study?

The data held about you relating to this study will be accessed by the study sponsor (University of Southampton). We will report the study and the results, submit the results to regulatory authorities, and may publish it in a scientific journal. If the results are published, or are presented at scientific meetings, your identity will not be revealed.

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St George's Healthcare NHS
NHS Trust

UNIVERSITY OF Southampton

All participant information that is collected from you as a result of your participation in this study will be de-identified (anonymous), which means that you will not be directly identified and the information cannot be linked to a specific study participant.
The recordings and information gathered about you will be stored by the University of Southampton on a password-protected computer for 10 years. All data will be destroyed and the speech recordings electronically deleted after 10 years of storage.

Where can I get more information?
You may call the chief investigator, Anna Barney on 023 8059 3734, or email the researcher of this study, Manuela Bung, at mb4g12@soton.ac.uk, who can answer any questions regarding information on this sheet, or queries about the study.

St George's Healthcare NHS Trust | University of Southampton

Participant Information Sheet (Partner)

Title of PhD project: **Conversational interaction in dementia**

Researcher name: Manuela Bung

Contact: mb4g12@soton.ac.uk

We'd like to invite you to take part in our research study. Joining the study is entirely up to you and before you decide we would like you to understand why the research is being done and what it would involve for you. Please feel free to talk to others about the study if you wish.

The first part of the Participant Information Sheet tells you the purpose of the study and what will happen to you if you take part.

Then we give you more detailed information about the conduct of the study.

Do ask us if there is anything that is not clear.

Please read this information carefully before deciding whether or not to take part in this research.

Who is organizing and funding the study?

The study is being organized by Manuela Bung (PhD student) and her supervisory team (Dr Anna Barney, Prof Carl Verschuur) at the University of Southampton (Engineering and the Environment, University of Southampton, Highfield Campus, Southampton SO17 1BJ United Kingdom).

The University of Southampton is the sponsor for this study and has overall responsibility for the study.

What is the research about?

We believe that there may be a relationship between how people talk and their general health. We think this may be particularly noticeable in people with certain forms of dementia. It is possible that some speech characteristics change over time and that this change could provide a simple way of assessing the progress of a person's disease.

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St George's Healthcare NHS Trust — University of Southampton

Why have I been chosen?

You have been chosen because your partner/close friend/relative has been diagnosed with a form of dementia. The clinical team at St. George's Hospital has recommended that he or she is suitable to take part in this study.

Do I have to take part?

No, it is up to you to decide whether or not to take part in this study. If you do decide to take part, you should keep this information sheet, complete the enclosed return slip (see your invitation letter) and send it to the research team on the envelope provided.
If you do not want to take part you do not need to do anything.
Whether or not you choose to take part will not affect the medical care of your partner in any way.

Why is it necessary for a relative/partner/close friend to take part as well?

We are looking for a conversation partner who knows the patient well, or who shares his or her daily activities. It is important that you are able to come with your partner. We will want to ask you some questions about your partner's speech, from your viewpoint.

What will happen to me if I take part?

If you decide to take part, you and your partner will be given an appointment time to meet the researcher Manuela Bung. This will be on the same day as one of your partner's routine clinic visits to St. George's Hospital. The researcher will explain the study to you again, and answer any questions you or your partner may have. You and your partner will then be asked to sign a consent form.
You and your partner in the conversation will then be asked to sit face to face at a table in a quiet room at St. George's Hospital. On the table there will be a map and an audio recording device. There will be also video recording devices in the corners of the room, recording your expressions and gestures. You will be asked to talk about the map on the table. You will be asked to draw a journey from one place on the map to another by listening to your partner's descriptions. Afterwards, your partner will be asked to repeat the speech task with a less familiar person, e.g. a student or a research assistant from St. George's Hospital, London. Meanwhile, you will have time to answer a questionnaire about your partner's speech behaviour during the task and in daily life. With your permission, this conversation will be audio- and video recorded. If you prefer not to be video recorded you can still take part in this

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study. We would like to record you on up to 4 occasions (each recording session will take place after your regular clinic visit at St. George's Hospital). If you have any questions during the session the researcher will always be on hand to explain further.

The whole session will last about an hour.
There will be short breaks included during the session when you can move around, or go to the bathroom, as needed.
You and your partner can withdraw from the study at any time you want without giving a reason and without any impact on your partner's current or future clinical care.

Are there any benefits in my taking part?
This study may not have a direct benefit for you, but you may feel satisfaction in knowing that your participation in this study could help create knowledge that leads to improved treatment of people with similar conditions to your partner's. However, you should be aware that positive benefits in the future cannot be guaranteed.

Are there any risks involved?
The study procedure does not involve any kind of treatment or intervention. We will try to make the situation as comfortable as possible for you and your partner. If you feel uncomfortable at any time, the speech task would not proceed and you will be free to leave.

Will my participation be confidential?
There will be no disclosure of research information except to other authorised persons working on the project. Every effort will be made to keep all information about you private. To protect the identity of your data, you will be assigned a unique number which with your data will be coded in the study database. Confidential information will only be shared with other people if you provide explicit consent.

What will happen if I don't want to carry on with the study?
We firstly want to remind you that your participation in this study is completely voluntary and do not want you to feel obligated to participate if you are uncomfortable with the idea. Should you change your mind at any time before, or during the study your rights or the health care service being provided will in no way be affected. If you do withdraw, we will need to use the data that has already been collected, so that we can analyse the results from the trial accurately.

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What if something goes wrong?

If you have concerns about any aspect of this study, please contact Manuela Bung, mb4g12@soton.ac.uk. If you are still unhappy and wish to complain more formally, please contact: Martina Prude, Head of Research Governance for the University of Southampton (Phone: 02380 595058; email: mad4@soton.ac.uk); or, alternatively, through the normal NHS complaints procedure (details available from your GP surgery). It is highly unlikely that you will be harmed during this study. If you are, however, you may have grounds for legal action against the University of Southampton and the NHS.

What will happen to the results of this study?

The data held about you relating to this study will be accessed by the study sponsor (University of Southampton). We will report the study and the results, submit the results to regulatory authorities, and may publish it in a scientific journal. If the results are published, or are presented at scientific meetings, your identity will not be revealed.

All participant information that is collected from you as a result of your participation in this study will be de-identified (anonymous), which means that you will not be directly identified and the information cannot be linked to a specific study participant.

The recordings and information gathered about you will be stored by the University of Southampton on a password-protected computer for 10 years. All data will be destroyed and the speech recordings electronically deleted after 10 years of storage.

Where can I get more information?

You may call the chief investigator, Anna Barney on 023 8059 3734, or email the researcher of this study, Manuela Bung, at mb4g12@soton.ac.uk, who can answer any questions regarding information on this sheet, or queries about the study.

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Blackshaw Road
Tooting
London SW17 0Q
Reception: 020 8672 1255

Recipient

Date

Dear Dr "<physician name>"

This communication concerns your patient “patient name”. She/He has agreed to participate in a NHS approved study that forms part of a PhD thesis at the University of Southampton in co-operation with the St. George’s Medical School, University of London. Study title: **Conversational interaction in dementia.** NHS Ethics number: ”13/LO/1301”.

The project aims to investigate a possible link between how people with certain forms of dementia talk and their general health. It is possible that some speech characteristics change over time and that this change could provide a simple way of assessing a person’s disease. As your patient is diagnosed with a form of dementia, she/he has been asked to participate in this study.

For eliciting conversation data, we will audio/video record the speech interaction between your patient and two people, one familiar to them and one less familiar. To stimulate conversation they will be asked to complete a simple speech task (describing a journey). All measurements of the speech will be made in a clinical room in St. George’s Hospital, London on the same day as their planned appointments for clinical assessment.

Should you have any questions, suggestions or concerns related to your patient participating in this project, please contact us. Tel: 023 8059 3734, Email: mb4g12@soton.ac.uk.

Yours sincerely

Manuela Bung
Postgraduate Researcher
Signal Processing & Control Group
University of Southampton

Appendix D Insurance Letter

Miller

Professional Risks
Dawson House
5 Jewry Street
London EC3N 2PJ
Tel: +44 (0)20 7488 2345
Fax: +44 (0)20 7481 0511
www.miller-insurance.com

VERIFICATION OF INSURANCE

To Whom It May Concern

We, the undersigned Insurance Brokers hereby confirm that the following described Insurance **is in force at this date.**

CLINICAL TRIALS NO FAULT COMPENSATION & LEGAL LIABILITY & ERRORS AND OMISSIONS INSURANCE

Insured: University of Southampton and/or University of Southampton Holdings Limited and/ or Subsidiary Companies and/ or any officer or member of the council or the senate or a committee whilst acting on behalf of the Insured

Period of Insurance: From: 1st August, 2013
To: 31st July, 2014 Both days inclusive, local standard time

Interest: Errors and Omissions
To indemnify the Insured in respect of claims first made against the Insured during the period of the policy arising out of negligent acts, errors or omissions.

Clinical Trials
To indemnify the Insured in respect of claims for compensation first made against the Insured during the period of the policy in respect of all trials undertaken or sponsored by the Insured.
Insuring Clause 1 – Compensation – Included
Insuring Clause 2 – Legal Liability - Included

Limit of Indemnity: GBP 20,000,000 any one claim and in all in the Period of Insurance including costs and expenses in respect of Errors and Omissions but any one event and in all in the Period of insurance or any applicable Extended Discovery Period plus costs and expenses in respect of Clinical trials.

Errors and Omissions sub limit of GBP 5,000,000 any one claim and in all in the Period of Insurance in respect of USA/ Canada jurisdiction.

Excess: Errors and Omissions GBP 12,500 each and every claim including costs and expenses increased to GBP 50,000 each and every claim including costs and expenses in respect of USA/ Canada.
Clinical Trials GBP 12,500 any one event including costs and expenses.

Insurers: 100% Certain Underwriters at Lloyds

Policy No.: PUNI01713

Miller

This document is furnished to you as a matter of information only.

The issuance of this document does not make the person or organisation to whom it has been issued an additional Assured, nor does it modify in any manner the contract of insurance between the Assured and Underwriters. Any amendment, change or extension of such contract can only be effected by specific endorsement.

Should the above mentioned contract of insurance be cancelled, assigned or changed during the above policy period in such manner as to affect this document, no obligation to inform the Holder of this document is accepted by the undersigned Insurance Brokers.

Signed ....[signature].... **Dated** ....5th August 2013....

Appendix E NHS Acceptance Letter

Health Research Authority

NRES Committee London - Queen Square
HRA Head Office
Skipton House
80 London Road
London
SE1 6LH

Telephone: 020 797 22580

12 December 2013

Miss Manuela Bung
13/3049
ISVR
University of Southampton, Highfield
SO17 1BJ

Dear Miss Bung

Study title:	**Turn taking during conversational interaction in Alzheimer's disease and frontotemporal dementia**
REC reference:	**13/LO/1301**
IRAS project ID:	**124708**

Thank you for your letter of 05 November 2013, responding to the Committee's request for further information on the above research and submitting revised documentation.

The further information has been considered on behalf of the Committee by the Chair.

We plan to publish your research summary wording for the above study on the NRES website, together with your contact details, unless you expressly withhold permission to do so. Publication will be no earlier than three months from the date of this favourable opinion letter. Should you wish to provide a substitute contact point, require further information, or wish to withhold permission to publish, please contact the REC Assistant Hayley Fraser NRESCommittee.London-Central@nhs.net

Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation as revised, subject to the conditions specified below.

Mental Capacity Act 2005

I confirm that the committee has approved this research project for the purposes of the Mental Capacity Act 2005. The committee is satisfied that the requirements of section 31 of the Act will be met in relation to research carried out as part of this project on, or in relation to, a person who lacks capacity to consent to taking part in the project.

Ethical review of research sites

NHS sites

The favourable opinion applies to all NHS sites taking part in the study, subject to management permission being obtained from the NHS/HSC R&D office prior to the start of the study (see "Conditions of the favourable opinion" below).

Non-NHS sites

Conditions of the favourable opinion

The favourable opinion is subject to the following conditions being met prior to the start of the study.

Management permission or approval must be obtained from each host organisation prior to the start of the study at the site concerned.

Management permission ("R&D approval") should be sought from all NHS organisations involved in the study in accordance with NHS research governance arrangements.

Guidance on applying for NHS permission for research is available in the Integrated Research Application System or at http://www.rdforum.nhs.uk.

Where a NHS organisation's role in the study is limited to identifying and referring potential participants to research sites ("participant identification centre"), guidance should be sought from the R&D office on the information it requires to give permission for this activity.

For non-NHS sites, site management permission should be obtained in accordance with the procedures of the relevant host organisation.

Sponsors are not required to notify the Committee of approvals from host organisations

Registration of Clinical Trials

All clinical trials (defined as the first four categories on the IRAS filter page) must be registered on a publically accessible database within 6 weeks of recruitment of the first participant (for medical device studies, within the timeline determined by the current registration and publication trees).

There is no requirement to separately notify the REC but you should do so at the earliest opportunity e.g when submitting an amendment. We will audit the registration details as part of the annual progress reporting process.

To ensure transparency in research, we strongly recommend that all research is registered but for non clinical trials this is not currently mandatory.

If a sponsor wishes to contest the need for registration they should contact Catherine Blewett (catherineblewett@nhs.net), the HRA does not, however, expect exceptions to be made. Guidance on where to register is provided within IRAS.

It is the responsibility of the sponsor to ensure that all the conditions are complied with before the start of the study or its initiation at a particular site (as applicable).

Approved documents

The final list of documents reviewed and approved by the Committee is as follows:

Document	*Version*	*Date*
Covering Letter		05 August 2013
Evidence of insurance or indemnity		30 July 2012
GP/Consultant Information Sheets	Appendix G-2	08 October 2013
Investigator CV	Manuela Bung	29 July 2013

Letter from Sponsor	Submission ID: 6906	26 July 2013
Letter of invitation to participant	2	08 October 2013
Letter of invitation to participant	Appendix E-2	08 October 2013
Other: CV: Dr Anna Barney - Academic Supervisor 1		15 May 2013
Other: CV: Carl Verschuuar - Academic Supervisor 2		05 August 2013
Other: Patient Documentation Sheet	2	08 October 2013
Other: Verification of Insurance- Miller		05 August 2013
Other: Appendix D- Patient Documentation Sheet	2	08 October 2013
Participant Consent Form: Patient	2	05 August 2013
Participant Consent Form: Partner	2	08 October 2013
Participant Consent Form: Appendix B	2	08 October 2013
Participant Consent Form	2	08 October 2013
Participant Information Sheet: Partner	2	08 October 2013
Participant Information Sheet: Appendix F	2	08 October 2013
Participant Information Sheet: Appendix F (2) CIS	2	08 October 2013
Participant Information Sheet: Patient	3	05 November 2013
Protocol	3	05 November 2013
Questionnaire: Questionnaire I	2	08 October 2013
Questionnaire: Questionnaire II	2	08 October 2013
Questionnaire: Appendix C-(first visit)	2	08 October 2013
Questionnaire: Appendix C- 2 (after the first visit)	2	08 October 2013
REC application	124708/4856 09/1/883	01 August 2013
Response to Request for Further Information	Letter from Manuela Bung	22 October 2013
Response to Request for Further Information	Letter from Manuela Bung	05 November 2013

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

After ethical review

Reporting requirements

The attached document *"After ethical review – guidance for researchers"* gives detailed guidance on reporting requirements for studies with a favourable opinion, including:

- Notifying substantial amendments
- Adding new sites and investigators
- Notification of serious breaches of the protocol
- Progress and safety reports
- Notifying the end of the study

The NRES website also provides guidance on these topics, which is updated in the light of changes in reporting requirements or procedures.

Feedback

You are invited to give your view of the service that you have received from the National Research Ethics Service and the application procedure. If you wish to make your views known please use the feedback form available on the website.

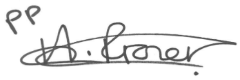
Further information is available at National Research Ethics Service website > After Review

13/LO/1301	**Please quote this number on all correspondence**

We are pleased to welcome researchers and R & D staff at our NRES committee members' training days – see details at http://www.hra.nhs.uk/hra-training/

With the Committee's best wishes for the success of this project.

Yours sincerely



Dr Yogi Amin
Chair

Email: NRESCommittee.London-Central@nhs.net

Enclosures: "After ethical review – guidance for researchers" *[SL-AR2]*

Copy to: *Dr Martina Prude*

Appendix F St. George's Hospital Host Site Permission

St George's University of London

St George's Healthcare NHS Trust

St George's Joint Research & Enterprise Office (JREO)
Ground Floor, Hunter Wing, St George's University of London,
Cranmer Terrace, Tooting, London SW17 0RE

Direct Line: 020 8266 6073
Email: nazzouzi@sgul.ac.uk

26/02/2014

Dr Peter Garrard
Reader in Neurology
Division of Cardiovascular Sciences
St George's, University of London
Cranmer Terrace, Tooting
London
SW17 0RE

Dear Dr Peter Garrard

PROJECT TITLE	Turn taking during conversational interaction in Alzheimer's disease frontotemporal dementia
REC Reference	13/LO/1301
JREO Reference	14.0013
CSP Reference (if applicable)	n/a
Sponsor	University of Southampton
Principal Investigator (PI):	Dr Peter Garrard

Notification of St George's Healthcare NHS Trust host site permission

Permission for the above research has been granted on the basis described in the application form, protocol and supporting documentation. The documents reviewed and approved were those specified in the ethics approval letter dated 12/12/2013. The protocol version approved is version 3 dated 05/11/2013.

Permission is granted on the understanding that the study is conducted in accordance with the Research Governance Framework, and NHS Trust policies. Permission is only granted for the activities for which a favourable opinion has been given by the REC. The permission may be invalidated in the event that the terms and conditions of any research contract or agreement change significantly and while the new contract/agreement is negotiated.

The research sponsor, the Chief Investigator, or the local Principal Investigator, may take appropriate urgent safety measures in order to protect research participants against any immediate hazard to their health or safety. The JREO should be notified that such measures have been taken. The notification should also include the reasons why the measures were taken and the plan for further action. The JREO should be notified within the same time frame of notifying the REC.

All amendments to this study (including changes to the local research team) need to be submitted in accordance with the guidance on IRAS. In addition any changes to the status of a study should be notified to the JREO.

Please note that the JREO is required to monitor research to ensure compliance with the Research Governance Framework and other legal and regulatory requirements.

Any intellectual property that is identified should be discussed with the JREO prior to any disclosure of this information by publication or presentations to ensure that all rights are protected.

At study closure, the JREO together with the approving ethics committee should be notified that the study is closed. Study findings should be disseminated as identified in the original ethics application (including participants where appropriate). Study files should be appropriately archived.

Please contact the JREO if you require any further guidance or information on any matter mentioned above. We wish you every success in your research.

Yours sincerely

Ms Nadia Azzouzi
On behalf of SGUL/SGHT
Joint Research and Enterprise Office

Appendix G - Transcript Familiar Conversation SD

RT: I am going to Diamond Mine ((mine: 136Hz-110Hz, flat)) / (0.31)
VT: Diamond Mine ((mine: 233Hz, flat-164Hz)) ?/> You next (no pause)
RT: Yah / you have it (0.47) / right ((right: 155Hz-358Hz)) (?/> You next) / (0.2)
Have you ((you: 205Hz-306Hz-289Hz)) ?/> You next (1.07)
VT: What's Diamond Mi [ne ((mine: 245Hz-148Hz, flat)) ?/> You next
RT: [It's written ((written:242Hz-173Hz-437Hz-106Hz, flat)) / (0.56)
VT: Alright ((107Hz-233Hz, flat-207Hz-87, flat)) / (0.23)
RT: Can I see ((see: 148Hz-324Hz)) ?/> You next (1.44)
No no no no (0.11) / on you:r on your paper ((paper: 148Hz)) / (0.18)
VT: Aha ((206Hz-217Hz, breathe in)) / (1.03)
RT: Just look at your paper ((paper: 153Hz-117Hz, flat, breathe in)) (0.56) / you see the Diamond Mine ((mine: 112Hz-205Hz)) /> You next then Me further (1.1)
VT: I don't under [stand Diamond Mine /[what's that ?/> You next
RT: [It's written / [it's it's written there you read it ((it: 137Hz-204Hz)) ?/> You next (0.04)
VT: Oh I [see /
RT: [Yah (?)/
VT: [yes yes ./
RT: [yah ((breathe in)) / okay so from that / <eh> / cross (0.44) / you can make a line down towards Diamond Mine / right ((flat, 114Hz-251Hz, flat)) /> You next then Me further (0.2)
VT: Alright ((254Hz-295Hz-129Hz-116Hz)) / (0.28)
RT: Yah ((210Hz-153Hz-227hz, TRP)) (1.18) /
[y
VT: [Where is Diamond Mine ((mine: 89Hz-92Hz)) ?/> You next (0.42)
RT: <E:h> / (0.41)
VT: Something around here / or what ((or what: 102Hz flat-108Hz-100Hz)) ?/> You next (0.12)
RT: No / you see it on the / <eh> / on the paper there ((there: 205Hz-239Hz)) /> You next then Me further (0.17)
VT: Oh yes yes [yes /
RT: [Yah ((211Hz-250Hz) (?)/> You next (0.8)
VT: Yah ((88Hz, fllat)) / (0.34)
RT: Yah ((255Hz-333Hz-310Hz)) (0.58) / okay ((382Hz-132Hz)) (0.22) / draw the line towards Diamond Mine ((mine: 116Hz, flat-148Hz)) /> You next then Me further (0.66+0.54)
VT: How would I do that ((that: 196Hz-207Hz-193Hz)) ?/> You next (0.83)
RT: With your (0.36) pen ((pen: 112Hz-97Hz-120Hz-113Hz)) (1.14) /
ri:g [th
VT: [Wha(0.26)t go aroun [d there
RT: [Tha:t's l- la ya that's it that's it (0.38) / [((onset sound))
VT: [Do this here ((here: 147Hz-260Hz-221Hz-155Hz-180Hz)) ?/> You next (0.25)
RT: Ya just draw a line dow [n ((down: 133Hz-111Hz-169Hz)) /
VT: [Like that ((that: 263Hz-85Hz, flat)) ?/> You next (0.96)
RT: Ya (0.13) ya ya ya (0.38) / that's: it ((breathe in, (0.31))) / now ((breathe in, (0.41)))) I am going pass the Graveyard ((yard: 97Hz-112Hz, TRP)) /> (You next) (3.61)
VT: Where is the Graveyard ((graveyard: 145Hz-252Hz-199Hz-92Hz, flat)) ?/> You next (0.45)
RT: <E:h> (0.89) / okay I am going pass the Graveyard ((graveyard: 176Hz-121Hz, flat-340Hz-318Hz)) (0.69) / towa:rds / o no no no no no (0.14) / [((laughter)) /
VT: [I have
RT: I don't think I ha
[ve / I don't know /
VT: [I haven't got a Graveya:rd ((very loud)) /> You next

RT:
you haven't got / okay / so I am going pass Garveyard towards (0.17) Carved Sto:nes / you have carved stones ((stones: 120Hz, flat-257Hz, flat-282Hz)) ?/> You next (1.6)
You look at [your ((not understandable word)) /
VT: [Yes I have got Carved [Stones ((very loud, angry)) (.)/
RT: [O:kay ((breathe in, (0.25)) / so go: / <eh> / draw the line towards (0.48) Carved Stones ((stones: 109Hz, flat-338Hz-293Hz)) /> You next then Me further (1.19)
VT: What to up there ?/> You next (almost overlap)
RT: Yah from here ((not understandable word)) / yah ((212Hz-288Hz-273Hz)) /.> You next then Me further (1.85)
VT: To go up here ((here: 138Hz-129Hz-241Hz-123Hz)) ?/> You next (0.05)
RT: <E:h> / yea you can go around or you can go around / <e> / anyway ((breathe in (0.3))) from Carved Stones (0.13) I go to the (0.49) Indian Country ((try: 114Hz, flat)) (1.14) / where the Indian (0.59) Tipi: tents: /
VT: Oh /
RT: You got tents Tipi tents ((tents: 266Hz-136Hz-343Hz-317Hz)) ?/> You next (0.91)
Oh you got something else there ((there: increase)) (2.64) / oka:y (0.43) / [yah
VT:
[Indian Country ((country: 169Hz-189Hz)) ?/> You next (0.15)
RT: Ye:s / what have you got in there / <e:h> ((0.84 duration)) / in between between Carved Stones and Indian Tipis ((tipis: 147Hz, flat-150Hz-117Hz, flat-123Hz)) (?)/> You next (1.01)
What's that ?/> You next (1.5)
Here (0.97) / what's th [at ?/> You next
VT: [Ravine ((235Hz-166Hz, flat)) /> You next (0.31)
RT: What is a Ravine ((breathe in)) 0.47) / o:kay (0.58) / <e:h> / ((stumbling)) / the- there is nothing about a Ravine here / so you go (0.32) towards (0.16) Indian Country now (0.27) / your line ((line: 105Hz, flat)) / (almost overlap)
VT: Do I go down the[re ?/> You next
RT: [Ya:h yah yah ((127Hz, flat)) (4.96) / o:kay /
VT: Yah ((256Hz-192Hz-265Hz)) ./> You next (0.08)
RT: From there we go: (0.38) / pass the Great Rock ((rock: 101Hz-114Hz-85Hz)) (0.48) / you got Great Rock / no ((181Hz-147Hz-211Hz)) (0.87) / you haven't got a Great Rock ((breathe in (0.65))) / [what about Gold Mine ((mine: 110Hz-96Hz-112Hz)) ?/> You next (0.95)
VT: [Yah /
Yah h [ere /
RT: [((Onset sound)) ((breathe in (0.24))) / okay ((breathe in (0.27))) / so: we [just
VT: [((not understandable word, 128Hz, flat)) / (0.4)
RT: Just draw the line / [yes
VT: [Through there ((there: 257Hz-129Hz)) ?/> You next (0.08)
RT: Yah (0.62) yah (2.29) ((drawing sound)) ri:ght (0.42) / yes ((breathe in) (0.22)) / oh don't have to look at me ((breathe in)(0.69)) / a:nd / <eh> / now you may have more stuff here ((breathe in) (0.44)) but after Gold Mine (1.07) I go pass Trout Farm / (almost overlap)
VT: I have got that Trout [Farm /(> You next)
RT: [O:kay / so (0.45) draw the line towards Trout Farm ((farm: 118Hz, flat)) / (0.15)
VT: Do I go down it or up it ((it: 247Hz-257Hz)) ?/> You next (almost overlap)
RT: It doesn't matter (0.26) / whatever you choose (0.68) / whatever (0.61) space you ha [ve /
VT: [I think I do thi [s /
RT: [Good (0.48) / a:nd we have Cavalry ((cavalry: 147Hz, flat-94Hz-110Hz, flat, TRP)) (0.85) / we have a fortress (0.33) / you got that ((that: 221Hz-237Hz)) ?/> You next (1.45) ((breathe in))

Go to fortress (0.11) / no ((179Hz-152Hz-253Hz-231Hz)) /
VT: No ((209Hz-186Hz)) / (0.6)
RT: No fortress ((breath in (0.65))) / so: pass the fortress to Cattle Stockade ((stockade: 130Hz-113Hz, flat)) / (1.2)
VT: Cattle Stockade is [here /
RT: [That's right / so you go down [to Cattle Stockade /
VT: [S:o I go down there ((there: 186Hz-137Hz)) (?)/> You next (then Me further) (0.14)
RT: Down there ((quiet, breathe in) (2.1)) / and after Cattle Stocka:de ((stockade: 193Hz, flat)) (1.91) / mhm o:h there is another Great Rock here ((here: 117Hz, flat-125Hz)) ((breathe in) (0.66)) / anyway (0.3) / a- after Cattle Stockade ((stockade: 173Hz-146Hz-224Hz-219Hz, TRP)) ((breathe in) (0.91)) / we enter the: (0.29) Bandit Territory ((territory: 110Hz, flat-117Hz)) / (1.34)
VT: Bandit Territory /
RT: [Ya:h /
VT: [Ye[s
RT: [So you go through [Bandit
VT: [Not Parched River (0.32) [Bed ?/> You next
RT: [Not- nothing about that /
[just Bandit [Territory /
VT: [No / [shall I put up there or [down ((down: 244Hz-153Hz-167Hz)) ((very loud)) ?/> You next (almost overlap)
RT: [Ya ((onset sound))
Yah is just there ((there: 123Hz-229Hz, flat)) /> You next then Me further (1.11)
Bandit Territory ((tory: 190Hz, flat)) (2.68) / a:nd (1.79) / that's it ((it: 306Hz-265Hz)) ./> You next (1.01)
VT: That's it ((it: 278Hz-246Hz)) ?/> You next (0.16)
RT: That's it (0.8) / I suppose you can make another cross there like up there ((there: 162Hz-129Hz)) / (0.46)
VT: Like this ((this: 238Hz-138Hz-143Hz)) ?/> You next (0.13)
RT: Yah ((139Hz, flat)) /

Appendix G - Transcript Familiar Conversation SD

Appendix H - Transcript Familiar Conversation PNFA

JB: We are going to dri:ve south ((south: 156Hz-107Hz-178Hz)) /> You next then Me further (0.51)
BB: I'm [not
JB: [F:
BB: I don't [under-
JB: [Understa:nd / we are going to make our way south ((south: 125Hz-75Hz-168Hz)) /> You next then Me further (0.09)
BB: Yah ((135Hz-167Hz-129Hz-187Hz)) ?/> You next (1.36)
JB: I am gonna go to be driving (0.33) / along the wa:y (1.86) / <ehm> (1.71) / we're going to pretend that we are driving (0.36) / alright (118Hz-220Hz) ?/> You next (0.4)
So this is pretend that you're going go that wa:y / and then you ((onset sound)) want to go the:re / and here and we'll finish here ((here:125Hz-107Hz)) ./> You next (0.74)
This is the finishing (0.86) / so I think that is what she is meaning to: (0.46) that what she means to do (0.37) / now we are going to drive / so ((long inbreath:1.31)) / how long will it take (0.11) / I don't know (0.31) / but (0.33)
BB: Because it says the:re on that side ((side:132Hz-181Hz)) ?/> You next (almost overlap)
JB: Yah ((141Hz-117Hz)) ./> You next (0.73)
BB: But thist is a different (0.27)
JB: Ya / you have to drive we- ((onset sounds)) / you have to draw yourself (0.43) / you see / so this is the Ravine ((ravine:94Hz-150Hz)) /> You next, then Me Further (Turn holding) ((0.15))
BB: Mhm ((very quiet, 169Hz-137Hz)) ./> You next (0.25)
JB: So we are going to drive (0.18) down south (0.14) for about (0.67) / <e:h> (0.09) / in the map is about (1.82) twenty centimetres / or whatever is there ((breath in (0.4)) / then we are going to town (1.47) / left ((relatively flat, slight increase)) (2.35) / we drive (0.26) left / (1.52) ((pencil noise))
BB: But there is different things in there (126Hz-132Hz) ?/> You next (0.11)
JB: Ya (0.22) / ya (01.4) / that's alright (0.46) / we don't need to worry about is is (0.34) ulti
[mately
BB: [And that one was (0.1) / it's non there ((there: 180Hz-138Hz)) ?/> You next (0.05)
JB: Ya you don't what / <e> / what is there / we just (0.23) / are we are going to go close to the Ravine (0.41) / that's it (0.8) / you go there (0.15) / [pass th-
BB: [((onset sound)) (0.18) /
[((onset sound))
JB: [Pa (0.19) / the [re is
BB: [We are going to the Carpenter's ((carpenter: 202Hz-209Hz)) ?/> You next (0.07)
JB: Well I don't have thas / but we are going to head towards the Ravine ((ravine: 147Hz-100Hz, flat)) /> You next then Me further (1.24)
You got the Ravine there ((there: 140Hz-160Hz)) ?/> You next (0.95)
BB: Ye:s / is it ((flat pitch)) ./> You next (0.12)
JB: Yah so we pass by the Ravine / north of Ravine / [the Ravine /
BB: [((onset sound, agreement?))
JB: s o you are going to drive that wa [y /
BB: [Ya /
JB: north of the Ravine ((ravine: 98Hz-134Hz-81Hz, flat)) /> You next then Me further ((pencil noise, Turn holding)) (2.77)
And then we have (0.39) s: (0.88, pencil noise) / under the Pine Grove (0.54) / and so we are going to go (0.11) p- close to the Pine Grove (0.91) / myah (0.73) / and then from there is going to be a bit of / <ehm> (0.59) / you know a twisted road (110Hz-362Hz-334Hz-345Hz, (turn holding)) (1.45) / a:nd we are going to the (0.48) Concealed Hideout / there is a Concealed Hideout somewhere ((where:264Hz-92Hz-207Hz)) (1.09) / so we are going to go somehow to the

Concealed (2.38) H- Hideout ((138Hz-98Hz-145Hz)) ((turn holding)) (4.17) / mh ya keep going down south (0.76) / and then from there we are going to head to where (0.36) the Boat House (0.59) / but you haven't got a Boat House there have you ((have you:135Hz-264Hz)) ?/> You next (0.69)
Have you got a Boat House ((house: 156Hz-207Hz)) ?/> You next ((almost overlap))
BB: Yeah in it ((it: 161Hz flat)) ./> You next (0.52)
JB: There is a second Boat House you see / there is another Boat House closer to you (increase, turn holding, 0.83) / which is (0.17) of the: / tz (0.4) / tip (0.24) of the Crane Bay ((bay; 135Hz-105Hz)) (0.72) / so this is the Crane Bay (0.25) / the tip of / <e> / there is another Boat House here ((increase, flat)) /> Turn Holding (2.74) ((pencil noise))
Nya (0.41) / and there is a Crane Bay ther- / <e:h> / is a Boat House just there (0.19) / I do [n't see it ((it:147Hz-130Hz-156Hz)) /> You next or Me further (2.59)
BB: [Is:- / <e> /
JB: Oh no /
BB: [Is this
JB: this one this one on the Crane Bay / there is a Boat House there ((there: 151Hz-106Hz-115Hz)) /> Turn Holding (2.57)
Yah (0.82) / | ˈeɪn | (1.25) / you can actually write if you want there a little Boat House ((house: 133Hz-161Hz)) /> You next then Me further (0.67)
[((onset sound))
BB: [It is here / this [is it ./
JB: [That is one / there is two boat Houses you see / there is [one
BB: [O:h /
JB: Boat House and another one just there (0.98) / at the tip of the of the of the Crane Bay (0.19) / there is a Boat House there ((there:133Hz-127Hz-165Hz)) /> Turn Holding (2.92)
BB: This is given me
JB: I [know and me as well /> Turn Holding (no pause)
BB: [I can't ((murmur))
I don't [understand /
JB: [Anyway (1.45)
BB: But (0.48) ((breathe out))
JB: There is a Boat House (0.12) the [re ((there: 135Hz-105Hz)) /
BB: [Yes / so shall I put
JB: Put [a ((not understandable word))
BB: [a boa-
JB: ((not understandable word)) or something box / <e:h> / a Boat house there / you know that's it (increase, flat) /> You next then Me further (2.59)
And then from there (0.05) /
BB: ((Onset sounds)) (0.18)
JB: That's it ((flat)) /> Turn holding (0.65)
We are going to drive alo:ng the coast (0.26) / on the Crane Ba [y (0.3) /
BB: [Mhm ((very quiet))
M [hm ./> You further
JB: [along the coast ((coast: 124Hz-109Hz-163Hz)) /> You next then Me further (1.5)
BB: Yah ((flat, slight decrease overall)) / (0.09)
JB: Pass / <ehm> (0.72) / that is / <e:h> / <eh> / another thing that there is there is a Coconut Palm tree (0.28) / just upon there where you are now / there is a Coconut Tree ((tree: 197Hz-284Hz-251Hz)) /> You next then Me further (1.69)
You don't see it / there you really haven't got it / I got it / (0.25)
BB: Ya [h ((89Hz-77Hz-154Hz)) ?/> You next

JB: [Is a Coconut Tree there (0.46) / so along there ((there: 124Hz-110Hz-164Hz)) /> Turn Holding (4.07) ((pencil noise))
BB: So have I (0.18) I have to put it (0.56)
JB: A little tree there you want (0.95) ((pencil noise)) / a little tree that's it (1.41) / just a quanti ((spanish word?)) just (0.88) / doesn't matter there ya ((very quiet)) / (0.74)
BB: Oh dear / (0.4, breathe in of JB)
JB: Ya / and then (0.94) / when we pass that tree (0.56) / we'll go (0.57) over north of the (0.75) Pebbled Shore (1.12) / all the north of the Pebbled Shore (0.3) / that's it (0.62) / keep going / ((very short onset sound)) / that's it / north of Pebbled Shore (0.6) / and then down to the Finish line (0.4) / that's it ((that's it: 127Hz-115Hz)) ./> You next (0.99)
BB: M [hm
JB: [Very well / that's it (0.74)/ that's it that's it that's it (1.17) / and there is the Finish line ((line: flat, slight increase, 98Hz)) ./> You next (2.4)
BB: This is v- very an- anno [n-
JB: [Well / I don't understand it either [too well /
BB: [No /
JB: but there you are is / <ehm> (1.6)
BB: Why is this (0.17) [Tilled
JB: [There is another an- there is ano- just a drawing / it's called Tilled Land (0.68) / Tilled Land / whatever that means (means: 101Hz-125Hz) (?)/> You next (1.32)
BB: Tilled Land / ya / wh- [peop-
JB: [Livi [ng
BB: [the farme [rs
JB: [Ya /
BB: t turning in all the (0.4)
JB: The soil ((soil: 141Hz-118Hz)) ./> You next (no pause)
BB: On the soil ((soil: 150Hz-138Hz, relatively flat)) /> You next or Me further, Turn holding?
JB: Ya (120Hz, flat) />

Appendix I - Transcript Familiar Conversation bvFTD

AS: We are starting at sta:rt ((start: 166Hz-120Hz)) / ((no pause))
RS: Okay / start at the start ./> You next (0.14)
AS: I'm walking along (0.16) / a:nd on my left I'm passing a Camera Shop ((shop: 156Hz-140Hz)) /> You next (0.5)
RS: Is that on your left ((left: 149Hz-110Hz)) ?/> You next ((no pause))
AS: Tz (0.4) / and then I'm preceding o:n (0.33) / [a:nd
RS: [So hang on / should I should I start drawing ((drawing: 184Hz-286Hz)) ?/> You next (0.43)
AS: You start drawing f:ollowing the line ((line: 171Zz-134Hz, flat, TRP))(1.04) / and then I'm (0.61) preceding on ((on: 148hz-164Hz, flat)) (0.59) / a:nd (0.61) do:wn (0.35) / I s: (0.19) then begin to pass the Parked Va:n he's got (0.46) / I don't know it's got something in there / but I think he is delivering something (0.37) / tz (0.82) / then I tu:rn round (0.55) behind the back of him ((him: 155Hz-143Hz-182Hz-174Hz, TRP)) (2.24) / a:nd (1.75) to my right I can see: some yachts (0.16) / on a: harbour on a: harbour on a lake sort of thing but it looks like is it a Yacht Club because it's a nice (0.48) little (0.1) / [<ehm> /
RS: [Mhm / okay ((Okay: 299Hz-117Hz)) ./> You next (0.28)
AS: Club house there (0.31) / tz (0.46) / anyway I precede on behind this Parked Va:n ((van: 167Hz-122Hz-167Hz (TRP))) (0.49) / and I see some Allotments on my right where they grow green vegetables / and there is a wheelbarrow out there (0.38) / various things / ((breathe in)(0.92))/ so the:n to my right are the Allotments / and I'm passing straight ahead (0.79) awa:y (0.38) keep going on for quite a long time ((drawing noise)) (1.57) / and then I take a left turn ((turn: 190Hz-120Hz-132Hz, TRP)) (1.13) / tz (0.37) / and I'm heading up towa:rds (0.45) a Disused Monastery ((monastery: 181Hz-127Hz, TRP)) ((drawing noise)) (2.53) / are you going to tell me anything which you couldn't see ((see: 241Hz-258Hz)) ?/> You next (0.53)
RS: No (0.45) / Disused Monastery is fine ((fine: 140Hz-125Hz)) ./> You next ((no pause))
AS: Yah ((204Hz-198Hz-235Hz)) / is there anything else on your map ((map: 184Hz-143Hz)) ?/> You next (0.2)
RS: Well there is a televan box on the right hand side at the Disused Monastery ((monastery: 135Hz-127Hz)) ./> You next (1.46)
AS: Ya (0.38) / ya but I have got that / was there anything before the Disused
[Monastery / because I have got
RS: [There is there is a Flight Flight Museum ((museum: 149Hz-117Hz-127Hz)) ./> You next (0.67)
AS: A what Museum ((museum: 203Hz-244Hz)) ?/> You next ((no pause))
RS: Flight Museum ((museum:135Hz-115Hz-122Hz)) ./> You next (0.16)
AS: And which side is the- (0.65) line is tha [t ((that: 162Hz-90Hz))?/> You next
RS: [On the right hand side of it ./> You next ((no pause))
AS: On the right hand side ((side: 193Hz-155Hz)) (0.22) / a Flight Mu [seum ((museum: 155Hz-139Hz)) /> You next
RS: [Mhm yes ((yes: 135Hz, flat-398Hz)) ./> You next (0.18)
AS: Is it got aircraft there ((there: 114Hz-91Hz-105Hz)) ?/> You next (0.13)
RS: No ((80Hz-159Hz-133Hz-132Hz)) / (0.92) ((drawing noise))
AS: Flight Museum / that' [s interesting ((interesting: 100Hz-241Hz, TRP)) ((drawing noise)(0.8))
RS: [Mhm ((very quiet) /
AS: okay (0.33) / and the:n (0.16) / I precede on pass the the Disused Monastery / which is really crumbling falling dow [n / and that's on my le:ft ((left: 197Hz-219Hz-121Hz)) /> You next then Me further ((drawing noise)) (1.95)
RS: [Mh ((quiet)) /

AS: And then straight ahead I go: (0.35) / and then I'll begin to turn around the right: ((right: 178Hz-129Hz)) /> You next ((almost overlap))
RS: Mhm ((154Hz-125Hz-167Hz)) ./> You next (1.7)
AS: A:nd can you see anything going on ahead ((ahead: 227Hz-277Hz)) ?/> You next ((almost overlap))
RS: Level Crossing ((crossing: 158Hz-146Hz)) ./> You next (0.4)
AS: A Level Crossing [is there ((there: 183Hz-126Hz)) ?/> You next (0.08)
RS: [Mhm ./> You further
Yes ((138Hz-134Hz)) ./> You next (0.18)
AS: Across the path ((path: 272Hz-217Hz-349Hz-329Hz)) ?/> You next (0.37)
RS: Yah ((174Hz-131Hz)) ./> You next (0.4)
AS: Do you think ((almost overlap))
RS: Yah / and then there is East Lake at the top ((decrease)) ./> You next (0.68)
AS: Alright / yah ((178Hz0163Hz-230Hz-223Hz, TRP)) (1.03) / but befo:re the Level Crossing is there anything before the Level [crossing ?/> You next
RS: [Telephone box on the right hand side ((side: 356Hz-331Hz)) ./> You next (0.81)
AS: Oh yah that's: (0.21) / okay ((177Hz-93Hz-197Hz (TRP))) (1.24) / well I have actually gone (0.25) left / my (0.11) the Disused Monastery is on my lef:t ((left: 193Hz-343Hz-321Hz-)) /> You next then Me further (0.31)
RS: Yes okay / [that's /
AS: [O [kay ((increase)) /
RS: [Yes ./> You next (0.13)
AS: And I precede straight o:n ((on: 228Hz-134Hz-147Hz)) (1.26) / beyond the Disused Monastery ((monastery: 158Hz-146Hz, flat)) /> You next then Me further (0.25)
RS: Yah ((177Hz-133Hz, flat)) (0.96) /
[Where do
AS: [Where do (0.18) / the Disused Monastery is now behind me ((me: 148Hz, flat)) / (0.14)
RS: Okay ((166Hz-121Hz)) ./> You next
AS: To the left ((left: 176Hz-360Hz)) /> You next then Me further (0.45)
RS: Yah ((146Hz-130Hz)) ./> You next (0.24)
AS: And then I precede on / and then I take a right turn and there is an Alpine Garden / can you see the Alpine Garden ((garden: 107Hz-207Hz)) ?/> You next ((no pause))
RS: Now I see what you mean you say you go ((go: 134Hz, flat)) (0.36) / and where is that / is it on your [right
AS: [That [that Alpine Garden is on my right ((right: 174Hz-114Hz)) /> You next (0.24)
RS: [That's wh-
Okay ((178Hz-123Hz)) ./> You next ((drawing noise)) (2.29)
[Yah ((169Hz-132Hz)) ./> You next
AS: [A:nd (0.69) I procede on the:re ((there: 174Hz-142Hz-228Hz (TRP))) (0.44) / and then (0.4) just beyond the Alpine Garden / I am gonna turn ri:gh [t ((right: 193Hz-135Hz)) /> You next, then Me further
RS: [Okay ((165Hz-116Hz)) ./> You next ((drawing noise)) (1.39)
AS: Tz (0.9) / and then after a short time I turn left: ((left: 166Hz-350Hz-337Hz (TRP))) (0.77) / so that the Youth Hostel is now on my right / can you see a Youth [Hostel (?)/> You next
RS: [No there isn't one ((one: 123Hz-137Hz)) ./> You next (1.17)
AS: Oh: (0.25) / well the Youth Hostel is now on my ri:ght: ((right: 190Hz-117Hz-181Hz)) /> You next then Me further ((almost overlap))
RS: Mhm ((133Hz-119Hz, flat)) ./> You next (0.94)

AS: And then once have gone pa:ssed the Youth Hostel (0.19) / I'm then turning to my right ((right: 169Hz-120Hz, TRP)) (2.08) / but on that road I can see to my lef:t ((left: 192Hz-345Hz)) (0.77) there is a Fence a Picked Fenc:e ((fence: 170Hz-127Hz)) /> You next (0.79)
RS: Y [es /
AS: [You got a Picked [Fence ?/
RS: [Yah / is that on your left hand side ((side: 133Hz-123Hz-337Hz)) ?/> You next ((almost overlap))
AS: That's way on my lef [t ((left: 132Hz, flat)) /
RS: [Okay ./> You next (0.98)
AS: Cause I am passing / my path goes quite near the Youth Hostel ((hostel: 156Hz-138Hz)) /> You next (0.16)
RS: Okay ((171Hz-124Hz)) ./> You next (0.49)
AS: <Tz> (0.74) / so then we go passed the Youth Hostel / the- (0.28) Youth Hostel is really to my right now ((now: 150Hz-217Hz)) /> You next, then Me further (0.16)
RS: Mhm ((172Hz-121Hz)) ./> You next (0.44)
AS: And then I take (0.25) a sha:rp (0.35) sort of diagonal straight turn down towards the Telephone Box ((box: 121Hz, flat (TRP))) (1.2) / and when I reach the Telephone Box ((box: 152Hz-465Hz)) (0.35) / that is now on my lef:t ((left: 162Hz-132Hz, flat, TRP)) ((drawing noise)) (0.97) / have you got any: other buildings ((buildings: 149Hz, flat)) /> You next ((drawing noise)) (0.59)
RS: Well I got Level Crossing ((crossing: 178Hz-114Hz)) /> You next (0.31)
AS: Where is the Level Crossing ((crossing: 199Hz-144Hz))?/> You next (0.33)
RS: <Eh> (0.29) / just n- north of the Telephone Box ((box: 171Hz-162Hz)) ./> You next (0.82)
AS: Just north / near the Thatched Mud Hut ((hut: 354Hz-144Hz)) ?/> You next (0.98)
RS: <Ehm> (0.47) / well / I haven't got a Thatched Mud Hut ((hut: 348Hz-316Hz ./> You next (0.35)
AS: Ah: ((141Hz-222Hz-127Hz)) (1.11) / well I proceed on pass the Telephone Box / the Telephone Box (0.4) is to my le [ft /> You next then Me further (1.01)
RS: [Okay ((151Hz-315Hz-120Hz)) ./> You next
AS: And the:n I take (0.12) a sharp turn on the path to my left (0.28) so that the Telephone Box is still on my left / ((almost overlap))
RS: Yah ((169Hz-129Hz)) ./> You next (1.06)
AS: And I precede on (0.15) u:p / (0.25)
RS: Mhm ((140Hz-123Hz)) ./> You next ((almost overlap))
AS: Towa:rds the Finish line / whe:re the East Lake is / [have you got Finish ((finish: 200Hz-345Hz)) ?/> You next (0.12)
RS: [Ya /
I haven't got Finish but I got towards the East Lake ((lake: 333Hz-313Hz-321Hz)) ./> You next (0.18)
AS: Yah ((172Hz-143Hz-149Hz)) ((drawing noise)) (0.71) / the Thatched Mud Hut is on my righ
[t ((right: 177Hz-123Hz)) /> You next
RS: [I haven't got that ((that: 164Hz, flat)) /> You next (0.33)
AS: You haven't got that / [so where is the Level Crossing ((crossing: 235Hz-142Hz, flat)) ?/> You next (0.24)
RS: [No ((very quiet)) /
<Eh> / I'm just passing it o:n the left hand side / as I getting up towards the East Lake ((lake: 119Hz-107Hz)) /> You next (1.1)
AS: And it's / okay / so Level Crossing is it (0.23) / do you think it is across the road ((road: 172Hz-128Hz-139Hz, flat)) ?/> You next (0.67)
RS: Don't know Darling ((darling: 110Hz, flat)) /> You next ((almost overlap))
AS: I guess it is if is Level Crossing ((crossing: 154Hz, flat)) / ((no pause))
RS: Yah ((155Hz-118Hz)) ./> You next (0.58)
AS: O:kay ((drawing noise)) (1.3) / a:nd (0.24) what else / have you- had anything else / which I haven't mentioned on the map ((map: 144Hz, flat)) ?/> You next (0.26)
RS: Mh / I don't know (0.14) / Picket Fence ((fence: 95Hz-285Hz-256Hz-287Hz-480Hz)) ?/> You next (0.42)

AS: No I mentioned that ((that: 152Hz, flat-177Hz)) ./> Me further/Turn Holding (0.58)
RS: <Ehm> /
AS: Up towards the finish: ((finish: 277Hz-127Hz-394Hz)) /> You next (0.1)
RS: Yah ((142Hz-125Hz, flat)) /> You next (0.22)
AS: There is again another Parked Van in the distan [ce ((distance: 187Hz-118Hz)) /> You next
RS: [Oh yes in distan [ce (.)/> You next
AS: [On my
le: [ft ((left: 179Hz-346Hz-127Hz)) (.)/> You next then Me further
RS: [Yah / okay ((346Hz-327Hz)) ./> You next (0.45)
AS: Well straight ahead really / where the Finish is ((is: 133Hz-137Hz)) /> You next then Me further (0.17)
RS: Mhm ((88Hz-113Hz-120Hz)) ./> You next ((no pause))
AS: Is a Parked Van ((van: 164Hz-147Hz, flat)) (0.34) / and the East Lake is: to my right ((right: 158Hz-172Hz-159Hz-351Hz)) /> You next ((no pause))
RS: Okay ((142Hz-118Hz, flat (TRP))) ((drawing noise)) (3.0) / okay ((145Hz-123Hz-354Hz-313Hz)) ./> You next (0.53)
AS: Have you anything else: / [which I haven't mentioned on the
RS: [No: /
Probably no [t ./
AS: [Ma [p ((map: 140Hz-130Hz)) ?/> You next
RS: [No (0.11) / ok [ay ((349Hz-124Hz)) (.)/
AS: [No ((185Hz-238Hz)) ?/> You next (0.1)
RS: No (0.11) / ok [ay ((148Hz-204Hz))/
AS: [No (0.13) / okay / ((almost overlap))
RS: Where about finishing ((finishing: 154Hz, flat-83Hz)) ?/> You next ((drawing noise)) (1.11)
AS: So: (0.44) you are finishing just beyo:nd ((beyond: 235Hz-207Hz, flat)) (0.35) / the East Lake's got a straight (0.62) edge to it ((it: 126Hz-459Hz)) /> You next then Me further ((almost overlap))
RS: Mhm ((144Hz-121Hz-126Hz)) (.)/> You next (0.74)
AS: Hasn't it ((it: 421Hz-458Hz)) (?)/> You next (0.08)
RS: Yah ((140Hz-128Hz, flat)) /> You next (0.16)
AS: And then it starts to be:nd rou:nd ((round: 187Hz-96Hz-128Hz)) [the co:rner /> You next then Me further (0.08)
RS: [Mh yah ((140Hz-112Hz)) /> You next
Okay ((170Hz-117Hz)) ./> You next ((almost overlap))
AS: Well the Finish is just beyond the end of the straight edge ((edge: 160Hz-123Hz)) /> You next (0.24)
RS: Okay / alright ((131Hz-113Hz)) ./> You next (0.76)
AS: Have you got anything else that you noti [ce ((notice: 167Hz-150Hz)) ?/> You next
RS: [No (0.18) / okay ((flat (TRP))) (0.52) / stop there ((there: 310Hz-288Hz)) ?/> (0.52)
AS: Stop there ((there: 132Hz-129Hz)) /> You next (0.22)

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