UNIVERSITY OF SOUTHAMPTON

FACULTY OF ENGINEERING AND PHYSICAL SCIENCES

School of Electronics and Computer Science

The DisENGAGE Framework: Supporting the Examination of Disengagement from Health-Based Digital Behaviour Change Interventions

by

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ABSTRACT

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THE DISENGAGE FRAMEWORK: SUPPORTING THE EXAMINATION OF DISENGAGEMENT FROM HEALTH-BASED DIGITAL BEHAVIOUR CHANGE INTERVENTIONS

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Examining engagement with Digital Behaviour Change Interventions (DBCIs) is a crucial aspect of Behaviour Change research, because it helps to explain why an intervention is or is not successful. However, the concept of *engagement* presents a number of issues for researchers. The lack of consensus surrounding a definition or approach to measurement is problematic, and this further complicates the issue of identifying an *engaged* user. This thesis presents an alternative, but complementary perspective by focusing on *disengagement*. Disengagement can be defined as 'the termination or non-usage of a DBCI', which can take three forms: behavioural (relating to the behaviour change process), digital (referring to the DBCI), or digital-behavioural (disengagement from both). This thesis will present a framework that will conceptualise and guide the exploration of disengagement. The DisENGAGE Framework evolved from a review of disengagement-related terminology (Chapter 3). This, in part, informed the selection of the Behaviour Change literature, which provided factors relating to *behavioural* disengagement (Chapter 4). Chapter 5 explores the Human-Computer Interaction (HCI) literature to identify *digital* disengagement factors. The DisENGAGE Framework has been tested using the PRIMIT, CIRCA, and Getting Active case studies (Chapters 8, 9, and 10). The analysis of the first two case studies highlighted several issues with retrospective analysis (conducting analysis on pre-existing data). The third case study used the DisENGAGE Framework at all stages of the study. This approach ensured that the relevant elements of disengagement data were collected and analysed. This led to the identification of various factors that were likely to lead to future disengagement. Furthermore, this analysis provided actionable recommendations to improve the DBCI and reduce digital-behavioural disengagement. A focus on disengagement provides a new perspective to DBCI research and further progresses the field of health-related behaviour change.

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Acronyms

BCI Behaviour Change Intervention. 1, 7

BCT Behaviour Change Technique. 7, 11, 12, 247

CeHRes Center for eHealth Research. 8, 11, 12, 15

CI-EMP Cochlear Implant Empowerment Measure. 148, 167, 253

CIRCA Cochlear Implant Remote CAre. 5, 118, 147–150, 153, 158, 161, 164, 166, 167, 235–237, 239, 240, 243–245, 247, 253

DBCI Digital Behaviour Change Intervention. iii, 1–5, 7–10, 12–15, 17, 18, 20, 23, 24, 27, 29–37, 39–45, 47–50, 52–59, 61, 63, 65, 68, 70–72, 74–76, 78–82, 84, 86, 87, 89–91, 94, 96–98, 101–106, 109, 111, 120, 125, 127, 129, 131, 134, 135, 138, 140, 142, 144–148, 150, 153–155, 157–161, 164–167, 169–171, 174, 177, 181–183, 185–191, 201–210, 212–219, 221, 224–228, 230–233, 235–258, 311, 313, 314, 329–333, 340, 341

HCI Human-Computer Interaction. iii, 2–5, 17, 20, 23, 27, 28, 41, 51, 54–56, 80, 90, 91, 93, 94, 96, 99, 101, 105, 131, 212, 221, 242, 243, 245, 247–251, 255–257

PBA Person-Based Approach. 8, 10, 11, 15, 221, 232, 233, 244, 245, 247, 255

PRIMIT PRimary care trial of a website based Infection control intervention to Modify Influenza-like illness and respiratory tract infection Transmission. 5, 107, 126–131, 135, 136, 142, 144, 232, 235, 236, 240, 245, 252, 253

UCD User-Centred Design. 242, 244, 245, 247

UE User Engagement. 5, 17, 20–23, 25, 28, 41, 55, 57, 71, 72, 75, 76, 78, 79, 91, 251

UX User Experience. 5, 17, 20–23, 25, 28, 55, 57, 59, 61, 71, 72, 79–81, 84–87, 90, 91, 183, 242, 251

Declaration of Authorship

I, Anna Charlotte Astley Weston, declare that the thesis entitled *The DisENGAGE Framework: Supporting the Examination of Disengagement from Health-Based Digital Behaviour Change Interventions* and the work presented in the thesis are both my own, and have been generated by me as the result of my own original research. I confirm that:

- this work was done wholly while in candidature for a research degree at this University;
- where I have consulted the published work of others, this is always clearly attributed;
- 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;
- I have acknowledged all main sources of help;
- 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;
- the first two case studies consist of secondary analyse which utilise data from pre-existing research projects. However the analysis is all my own work;
- the third case study piggybacked upon a research study which aimed to increase levels of activity amongst asthmatics. However, the planning and collection of data was carried out in collaboration with project's researchers and the analysis is all my own work;
- none of this work has been published before submission

Signed:.....

Date:.....

Acknowledgements

To do.

My thesis has been full of these little notes to myself, often telling me to look this up or return to this later. Finally, these have all been deleted. It is done and there are so many people that I truly have to thank for getting me here.

I would like to thank Dr Mark Weal and Dr Leanne Morrison for their advice and feedback during this process. I would also like to especially thank Dr Mary Steele for her understanding and time at a point when it was greatly needed. Finally, I would like to thank my parents for their continued, unwavering encouragement and support. A special thanks to my Dad for making sure that this thesis was not just page after page of em dashes (–).

I am lucky to have incredible friends and family who have always been there for me and kept me going. There are too many of you to name here but you know who you are, thank you so much!

Chapter 1

Introduction

Health-related Behaviour Change Interventions (BCIs) aim to provide the tools and strategies to address or manage barriers to behaviour change. Digital Behaviour Change Interventions (DBCIs) take advantage of the advancements and ubiquitous nature of technology by offering interventions at scale, reducing the pressure on healthcare professionals, and offering a more tailored user experience. DBCIs can also track behaviour over time, send notifications and reminders, and capture contextual information about the individual. However, a user has to engage with a DBCI for it to be effective and therefore researchers are trying to understand how to improve engagement.

In 2016b, Yardley *et al.* published an expert review into the current state of engagement research with DBCIs. This workshop was attended by an international committee who proposed a number of avenues for future research including (Yardley *et al.*, 2016b, p.839):

1. 'Further develop and test taxonomies and models of engagement, considering how technological and behavioral elements combine to influence effective engagement'
2. 'Investigate and validate complementary and non-intrusive measures of effective engagement and novel methods of analyzing and triangulating qualitative and quantitative data'

These research goals look to improve the experience and effectiveness of DBCIs by increasing engagement. However, this thesis approaches this challenge from a different perspective, through disengagement. This introduction explains how disengagement research can address some of the challenges of engagement research, sets out the research aims, and explains the structure of the thesis.

1.1 Engagement vs. Disengagement

Engagement is a complex phenomenon that is difficult to define, measure, and identify. These difficulties are closely interrelated and make engagement research challenging. This section will explore these challenges further, highlighting how disengagement research can provide a different perspective.

Engagement is conceptualised – within health-based DBCI research – in a number of ways but often it is reduced down to a behavioural component; measuring engagement simply as usage of the intervention. However, many researchers – across Psychology and Human-Computer Interaction (HCI) – would argue that this reductive approach oversimplifies the phenomenon.

Perski *et al.* (2017, p.258) carried out a review of engagement literature, which lead to the following definition of DBCI engagement '(1) the extent (e.g. amount, frequency, duration, depth) of usage and (2) a subjective experience characterised by attention, interest and affect'. Researchers within HCI have taken this a step further by defining engagement as 'the *emotional*, *cognitive*, and *behavioral* experience of a user with a technological resource that exists, at any point in time *and* over time' (Lalmas *et al.*, 2014, p.3). This lack of consensus within and across disciplines makes it difficult to operationalise engagement. In comparison, I propose that disengagement is best defined as **the termination or non-usage of a DBCI**. This can either be session-based – at the end of a session – or long-term – where the user has an extended period of non-usage or has no intention of returning to the system. A clear definition helps researchers identify and measure this phenomenon.

The lack of definitional consensus creates problems for measurement because it is unclear how and what should be measured. Usage data is often used to measure the *behavioural* aspect of engagement. However, the data from session-based metrics is not always accurate or reliable. For example, 'time spent on a page' records how long a webpage or app is open on the screen. It does not record what the user is doing during this time, the 'focus of [their] engagement' (Peters *et al.*, 2009, p.2), or their psychological reactions. This individual may have walked away from the screen, be switching between different apps, or absent-mindedly scanning the page. As a result of these factors, imprecision in usage data makes it difficult to identify the extent to which an individual is actually engaged. Although the individual has opened the intervention and on some level may be engaged, this level of engagement is unlikely to lead to *effective engagement*. Yardley *et al.* (2016b, p.835) define 'effective engagement' as engagement that leads to a positive behaviour change outcome.

In addition to the issue of validity, usage data also only provides the behavioural component of engagement. Definitions refer to experiential, emotional, and cognitive aspects

of engagement, using terms such as 'interest' and 'affect' and it is unclear how to operationalise these terms within research. For example, what level of interest or affect is required to *show* engagement? How can these be accurately measured? In comparison, digital disengagement is more easily identified; users are either using or not using the DBCI.

Lalmas *et al.* (2014, p.7) suggest collecting engagement data through self-reporting, physiological approaches, and web analytics. Self-reporting and web analytics are routinely used within engagement research. However, physiological measures – such as eye tracking, mouse pressure, and biosensors (Lalmas *et al.*, 2014, p.31) – require specialised equipment, expertise, or both. It is unlikely that the majority of researchers will have the resources for this type of data collection and therefore engagement research may be missing a crucial aspect of the phenomenon.

There are therefore a number of barriers to successful engagement research; a lack of consensus regarding a definition, the challenges associated with measuring the facets of engagement, and the difficulty in identifying an engaged user. On the other hand, disengagement can easily be defined as a termination or lack of usage and this can be identified through usage data. Every individual that has used the DBCI has disengaged at the end of the session (session-based disengagement). Understanding the reasons for this termination can provide insight into the user experience. This type of disengagement can be positive – if the user achieved their goals for that interaction. However, an aspect of the DBCI may lead a user to prematurely disengage – such as a poor usability – and addressing these issues could prevent this negative interaction.

There are two additional justifications for focusing on disengagement rather than engagement. Firstly, high rates of dropout are a serious problem for health-based DBCIs (Eysenbach, 2005, p.2). Depending on the level of usage before disengagement, these individuals may not have acquired the necessary tools and knowledge to continue addressing their behaviour change attempt. Furthermore, these negative interactions will be remembered as past experiences and may affect future attempts with DBCIs; Venkatesh & Bala (2008, p.280) show that past experience feeds into a user's intention to use a technology. It is therefore important to better understand disengagement from DBCIs by identifying the factors that can lead to non-usage.

Secondly, research within HCI suggests that aspects such as emotion – the 'conscious experience of affect' – are unique to the individual (Norman, 2004, p.11). McCarthy & Wright (2004a, p.83-87) explain that emotion is inextricably linked to the person; their situation, their feelings towards the situation, and perceptions and beliefs about an object. They explain that an individual brings as much to an interaction with technology as the designer, through past experiences and personal disposition (McCarthy & Wright, 2004a, p.105). These unique personal influences on an interaction suggest that it is not possible to design a DBCI that will be engaging for all users, all of the time. However,

identifying and eliminating these barriers to usage should improve a user's experience with the DBCI, increasing the likelihood of user retention and adherence.

Disengagement research has a number of advantages over engagement. It is easy to define disengagement as the non-usage of a DBCI. This allows researchers to easily identify a disengaged user through usage logs. Furthermore, contextualising this non-usage and further understanding their user experience can help identify barriers to usage and reduce disengagement.

A framework is useful because it provides a structured tool that encapsulates different aspects of a phenomenon.In this case it helps to identify the factors from both behavioural and digital disengagement and ensures that researchers explore the relationships between these inter-related elements. It is always tempting to focus on one or other particular aspect of disengagement, but a framework provides a more holistic approach to help researchers gain a fuller understanding of the interaction between an individual and a DBCI.

> Adopting a new formal framework of disengagement factors will enable a better understanding of why users disengage from DBCIs, and therefore contribute to improved and more holistic designs in the future.

The following four research aims have emerged from this thesis statement.

1.2 Research Aims

In order to identify barriers to usage and reduce the likelihood of disengagement with DBCI, it is necessary to holistically explore the interaction between a user and an intervention. Engagement research faces a number of challenges, but by focusing on disengagement researchers can explore this phenomenon from a different perspective.

This thesis explores the concept of disengagement from DBCI using an interdisciplinary approach, which combines research from Behaviour Change as well as Computer Science literature. This work aims to progress the field of engagement – using disengagement – to better understand how individuals interact with DBCIs. The Research Aims (RA) are as follows:

RA1 Develop an overarching vocabulary to describe aspects of disengagement with behavioural intervention research.

RA2 Review and critique the latest Behaviour Change and HCI research to create a theoretical framework for disengagement from DBCIs.

RA3 Investigate how qualitative and quantitative (usage) data can be used to understand disengagement using the framework.

RA4 Demonstrate how the theoretical framework can guide researchers through the process of disengagement research, including planning for, collection of, and analysing disengagement data.

1.3 Thesis Structure

Chapter 2 provides an overview of DBCIs and how they are developed and evaluated. Furthermore, it explores how engagement is related to a DBCI's effectiveness and the challenges with using engagement as an evaluative measure. Finally, it introduces a different approach – disengagement research – which will provide researchers with a new process to better understand their participants' usage and reduce premature non-usage.

Chapter 3 investigates the range of terms used to describe and research areas of disengagement (RA1). It presents a taxonomy of disengagement terms, explaining how these terms interact with one another in the wider context of disengagement research.

Chapter 4 explores the current literature and research in behaviour change including models and theories. These are critiqued to understand the behavioural factors that may influence DBCI disengagement (RA2). Chapter 5 explores the different terms which relate to (dis)engagement within HCI. It critiques models of technology adoption, User Engagement (UE), and User Experience (UX) to propose the technological barriers to DBCI usage (RA2). Chapter 6 proposes the DisENGAGE Framework, which combines behavioural and technological barriers, to present the factors that may influence disengagement from DBCIs (RA2).

Chapter 7 is a methodology chapter, which explains why a mixed methods approach is required to accurately research disengagement (RA4) and why a case study approach was taken within this thesis. It also introduces the LifeGuide software and presents various scripts and graphs for exploring usage data (RA3).

Chapter 8 presents the first case study: PRIMIT (PRimary care trial of a website based Infection control intervention to Modify Influenza-like illness and respiratory tract infection Transmission). This consists of a retrospective analysis of usage to better understand how to approach disengagement research with a session-based intervention (RA3).

Chapter 9 presents the second case study: CIRCA (Cochlear Implant Remote Care). This DBCI was intended to be 'used when required' and therefore a disengaged user is more difficult to identify. The study reports a dropout rate of 2%, which is very low.

This case study explores the usage patterns of this type of DBCI and examines this dropout rate (RA3).

The retrospective analysis conducted in chapter 8 and 9 highlighted several issues with using usage data that was not specifically collected to explore disengagement. In addition, these chapters illustrate the need for a mixed methods approach (RA3). Chapter 10 presents the final case study, called Getting Active, which aims to help asthmatics increase their level of activity. The DisENGAGE Framework was used to plan for, collect, and analyse the Getting Active data, in collaboration with the intervention designers (RA4). This led to a better understanding of the intervention usage and recommendations for future developments. This analysis also proposed a number of developments for the DisENGAGE Framework which are put forward in chapter 11.

Chapter 12 discusses several themes that emerged across the three case studies. This chapter explores these findings by contextualising them within current research. Furthermore, this chapter helps to identify some of the important considerations of disengagement and interdisciplinary research.

Chapter 13 concludes the thesis by drawing together the findings of this work and suggests future directions for disengagement research.

Chapter 2

Developing DBCIs

This chapter explains the theory behind Digital Behaviour Change Interventions (DBCIs) and how they are developed. It also explores the relationship between engagement and effectiveness and explains the need for an accessible evaluative tool that can be used by all DBCI researchers to better understand their intervention and DBCI uptake.

2.1 Behaviour Change Theories and Interventions

Behaviour Change theories explain what leads to the performance of a behaviour - i.e., the 'why, when and how' (Michie *et al.*, 2014a, p.22). Such theories can therefore help to identify the 'mechanisms of action', i.e. the processes that need to be targeted by the DBCI (Connell *et al.*, 2018, p.1). Many of these theories also contain 'moderators of change' factors which influence the behaviour change process but do not directly cause a behaviour to occur (Davis *et al.*, 2015, p.324).

Behaviour Change Interventions (BCIs) are designed to help individuals or populations to change their behaviour through a particular activity or set of interlinking activities (Michie *et al.*, 2014b). Digital Behaviour Change Interventions (DBCIs) 'employ digital technology to promote and maintain health, through primary or secondary prevention and management of health problems' (Yardley *et al.*, 2016a, p.814). In other words, they help to address barriers to behaviour change and take advantage of the ever updating and ubiquitous nature of technology. For example, DBCIs have been used to address issues such as excessive alcohol consumption (Crane *et al.*, 2017), mental health (Richards *et al.*, 2016; Lobban *et al.*, 2017), and smoking cessation (Ybarra *et al.*, 2016).

Interventions contain various components, including specific 'Behaviour Change Techniques' (BCTs). Behaviour Change Techniques (BCTs) are the 'smallest component' of the intervention that have the potential to change behaviour, and are also referred to as the intervention's 'active ingredients' (Michie & Johnston, 2012, p.2). To effectively

change a user's behaviour, the DBCI must contain BCTs which address the mechanisms of action of the target behaviour (Michie *et al.*, 2018, p.502). To identify the correct mechanisms of action, DBCI designers first have to correctly choose an appropriate theory (or theories) that model the target behaviour. This is incredibly challenging as there are numerous behaviour change theories. According to Michie *et al.* (2014a) there are 83 different theories of behaviour change. However, the identification of the theory and mechanisms of action are just one of the recommended steps in the DBCI development process.

There are numerous approaches to developing DBCIs and often researchers fail to explicitly state the one that they have followed. The following three examples provide a range which prioritise different focal points, including the theory, the person attempting to change their behaviour, and a holistic approach which considers all stakeholders. Many of these process use additional tools or combine with other approaches during the developmental process. Furthermore, the success of these approaches will depend upon numerous factors such as the identified theory or the target behaviour. This chapter does not aim to critique these approaches but rather provides a background context in which to explain how engagement (and disengagement) relate to these processes.

2.2 DBCI Development Processes

It is widely accepted that DBCIs should be based on theory. However, publications often fail to report their development process, making it difficult to draw comparisons between DBCIs and research studies. Numerous approaches, frameworks, processes, and tools have been developed to try to standardise DBCI development and help researchers design and evaluate interventions more effectively.

This section presents three different approaches. The first – the 'Development-Evaluation-Implementation Process' (Craig *et al.*, 2008, 2013) – was produced by the Medical Research Council (MRC) and focuses mainly on theory and research process. The second – the 'Person-Based Approach' (PBA) – was developed by Psychologists and focuses on the person attempting to change their behaviour, their needs and values (Yardley *et al.*, 2015). The final approach – 'Center for eHealth Research' (CeHRes) Roadmap – presents a holistic process which focuses on eHealth technology and the wide range of influential stakeholders (van Gemert-Pijnen *et al.*, 2011; Nijland, 2011; van Velsen *et al.*, 2013). This range of approaches shows the variety of methodologies and developmental stages used by DBCI developers. Each approach proposes a different set of focal points or stages, which highlights the challenges faced by DBCI developers.

2.2.1 The 'Development-Evaluation-Implementation Process'

To try and standardise the development and reporting of DBCIs, the Medical Research Council (MRC) published the 'Development-Evaluation-Implementation Process' (Craig *et al.*, 2008, 2013) (see Figure 2.1).

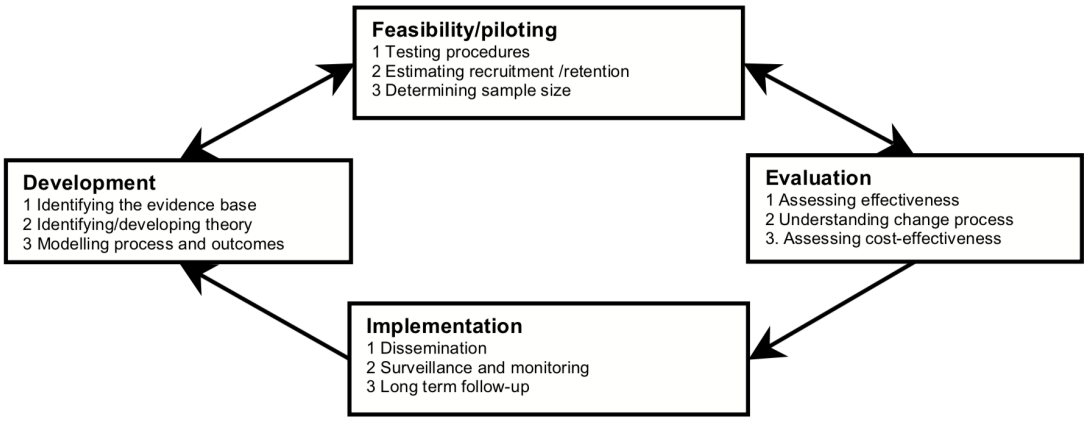

Figure 2.1: 'Key Elements of the Development and Evaluation Process' taken from Craig *et al.* (2008)

This process presents four phases of development and evaluation: 'development', 'feasibility and piloting', 'evaluation', and 'implementation'. The 'development' stage considers the target behaviour and the context of the behaviour change. Researchers can use similar interventions and other 'existing evidence' to better understand the context-specific requirements of an effective intervention (Craig *et al.*, 2008, p.980). During this stage developers should also identify the relevant theory that can explain the mechanisms of action, drawing upon existing evidence or conducting new research (if required). Finally researchers should model the complex intervention to better understand the new intervention and develop appropriate evaluation criteria.

The 'feasibility and piloting' stage is designed to ensure that the research study and intervention is achievable. Piloting can help to identify issues of 'acceptability, compliance, delivery' and 'recruitment and retention' before a full scale evaluative study is conducted (Craig *et al.*, 2008, p.981). This stage can also test the evaluation process and ensure that the study will produce useful data.

During the 'evaluation' stage a researcher should assess the DBCI's 'effectiveness', 'measure outcomes', and consider the 'process evaluations'[1] (Craig *et al.*, 2008, p.982). The specific research questions and focus of the study will impact these assessments. Moore *et al.* (2015) explain in more depth the considerations relating to process evaluations, exploring 'fidelity', 'dose', 'adaptations', 'reach', 'contextual factors', and 'unexpected pathways and consequences'. Finally, the 'implementation' stage considers the deployment of the DBCI, which includes 'monitoring' and any 'long term follow-up'.

[1] Defined as the 'way in which the intervention under study is implemented' (Craig *et al.*, 2008, p.982)

This framework is meant to guide but not be 'prescriptive' (Craig *et al.*, 2013, p.591). In spite of this, it has still been criticised for its lack of detail (De Silva *et al.*, 2014). This is one of the reasons for the more in-depth process evaluation published by Moore *et al.* (2015) and the framework's intended update in 2019 (Skivington *et al.*, 2018). However, this framework does provide an approach for DBCI development that is recommended by the Medical Research Council (MRC).

2.2.2 The 'Person-Based Approach' (PBA)

The 'Person-Based Approach' (PBA) aims to keep the individual who will use the intervention at the core of development (Yardley *et al.*, 2015) (see Figure 2.2). It aims to understand both their psychosocial context and individual perspectives in order to deliver an intervention that is fit-for-purpose. The approach has several key components laid out by Figure 2.2. However, Yardley *et al.* (2015) also set out four key stages of development: 'planning', 'design', 'development and evaluation of acceptability and feasibility', and 'implementation and trialing', which are briefly explained below.

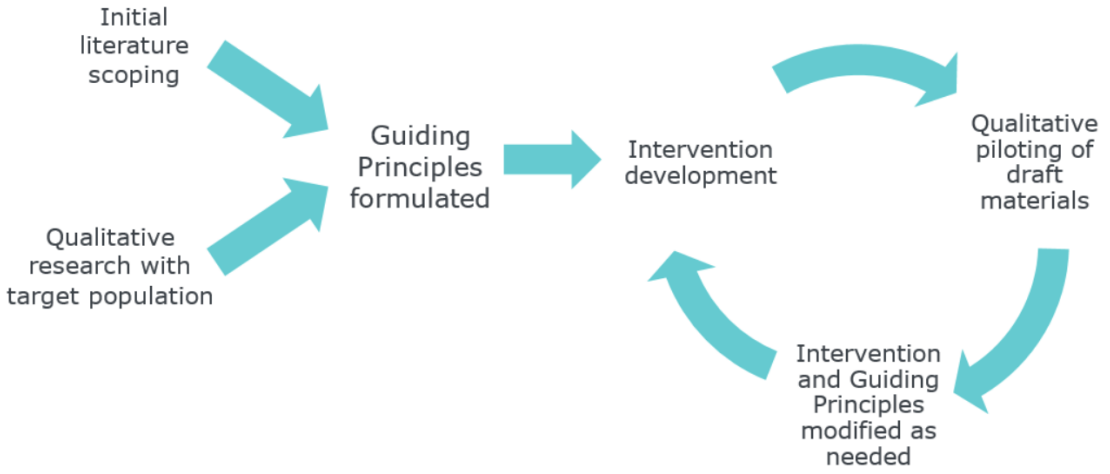

Figure 2.2: The 'Person-Based Approach Core Methods' taken from Yardley *et al.* (2018)

During the 'planning' and 'design' stages researchers carry out in-depth qualitative and mixed methods research with the target users. This work consists of researching similar interventions and published quantitative evidence, reviewing qualitative studies about the target population or related interventions, and identifying relevant theories of behaviour.

These investigations lead to the development of the 'guiding principles', which identify the main design objectives of the intervention and explain how these are achieved through its design and key features (Yardley *et al.*, 2015). They provide a summary of the intervention priorities, which can easily be referred to during the different stages of

intervention development. This ensures that the main objectives and features of the intervention are not compromised during the design and evaluation stages.

The 'development and evaluation' stage follows an iterative cycle of user generated feedback and intervention modification. This stage includes observed and independent usage to explore real-time reactions and also real-world experiences of use. It is important that developers carefully consider user feedback to ensure that alterations to the design are not in conflict with the guiding principles or overall intervention objectives.

Finally, researchers progress to the 'implementation and trialing' stage. This involves the investigation of further real-world usage patterns in order to refine and evaluate the intervention, including considerations for future implementation and alternative contexts. This would include an analysis of effectiveness, cost-effectiveness, and analyses of implementation (such as fidelity and reach) (Yardley *et al.*, 2015).

PBA was designed to complement methodologies such as 'theory-based' and 'evidence-based' approaches (Yardley *et al.*, 2015). Its main goal is to design an intervention that is as engaging, persuasive, and meaningful to the target user, and to identify the best ways to design and implement the relevant BCTs. To achieve this, Yardley *et al.* (2015) specifically encourages the use of additional frameworks and tools, such as 'Intervention Mapping' (IM) (Bartholomew *et al.*, 1998; Bartholomew & Mullen, 2011; Kok *et al.*, 2016), the 'Behaviour Change Wheel' (BCW) (Michie *et al.*, 2011), or the creation of a 'Logic Model' (Baxter *et al.*, 2014). Yardley *et al.* (2015) also recognises the benefit of combining PBA with other approaches such as the 'CeHRes Roadmap', which is discussed below.

2.2.3 The 'Center for eHealth Research' (CeHRes) Roadmap

The 'Center for eHealth Research' (CeHRes) Roadmap is a holistic framework to guide the development, evaluation, and implementation of eHealth technologies (van Gemert-Pijnen *et al.*, 2011; Nijland, 2011; van Velsen *et al.*, 2013). van Gemert-Pijnen *et al.* (2011) explains that 'eHealth' refers to 'all kinds of information and communication technology used for supporting health care and promoting a sense of well-being'.

This CeHRes Roadmap presents five stages of development, which are followed iteratively (see Figure 2.3). However, before starting this process, a multidisciplinary project management team should be formed to ensure co-operation and collaboration between those producing the eHealth technology and the stakeholders – especially the users (van Gemert-Pijnen *et al.*, 2011).

The 'contextual inquiry' stage involves the gathering of data about the intended users and their usage environment (van Gemert-Pijnen *et al.*, 2011). This data is collected through a combination of workshops, field observations, and the generation of personas

and scenarios. This collected data helps to identify the goals of the technology and understand why any current systems are not working. At this stage all relevant stakeholders are identified.

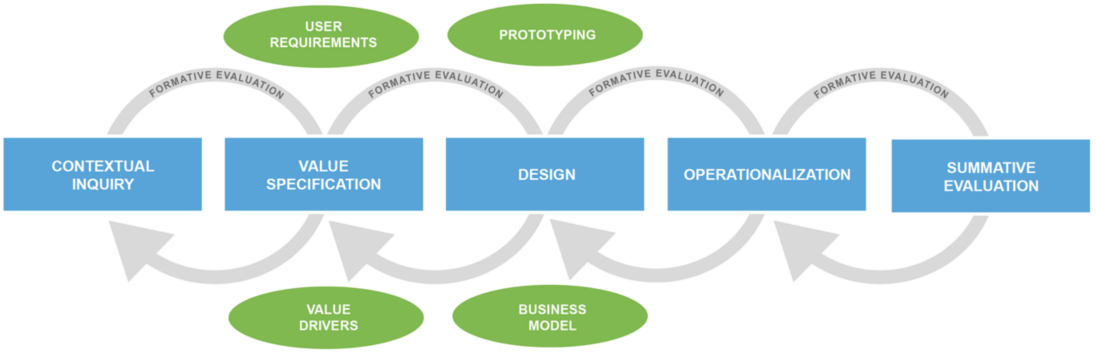

Figure 2.3: The 'Center for eHealth Research' (CeHRes) Roadmap taken from van Gemert-Pijnen *et al.* (2011)

The 'value specification' stage quantifies the values of key stakeholders, including their social and behavioural values as well as any economic and medical considerations (van Gemert-Pijnen *et al.*, 2011). These values drive the development of the user requirements, which are ranked according to their significance in the overall objective of the technology. The outputs of each stage – in this case 'user requirements' and 'value drivers' – are illustrated as ovals in the diagram (see Figure 2.3).

The 'design' stage involves the building of prototypes by translating functional requirements into technical requirements (van Gemert-Pijnen *et al.*, 2011). This involves mock-ups and designs that are iteratively tested with users, including use in real-world contexts. The 'operationalisation' stage considers the adoption process and use of technology in practice. A business model is developed to further guide the adoption process, including in-depth financial analyses and any arrangements with other organisations. Finally, there is the 'summative evaluation' to assess the clinical, organisational and behavioural impact of the eHealth technology. During this stage the eHealth technology is evaluated according to its uptake and effect (van Velsen *et al.*, 2013).

The CeHRes Roadmap aims to guide the development of eHealth technologies. van Gemert-Pijnen *et al.* (2011) explain that eHealth technologies are not solely intended for 'medical monitoring' but should also aim to support all '5M-eHealth' goals: 'measurement (e-diagnose), monitoring (observation), mentoring (nudging), motivation (support), and management of data (automated integration of different data)'. This broader scope includes DBCIs but also considers additional types of technology such as 'electronic health records' and 'robotics' (van Gemert-Pijnen *et al.*, 2011). The CeHRes Roadmap therefore focuses on the different considerations of technology development and business, rather than simply the BCTs. This provides a different perspective to the other two frameworks but this does not mean that they are mutually exclusive (Yardley *et al.*, 2015).

2.2.4 Summary: DBCI Development Processes

These three frameworks are examples of the different approaches taken by intervention developers. However, they are only a sample. There are numerous other frameworks, processes and models that aid the development and evaluation of DBCIs. Furthermore, with advancing technology and availability of data these models and approaches are constantly being updated and improved to take advantage of new developments (Michie *et al.*, 2017). Although the three frameworks discussed suggest slightly different stages and points of focus, they all show an iterative process and a need for evaluation, especially in terms of the 'effect' or 'effectiveness' of the DBCI. The next section explores the relationship between 'effectiveness' and 'engagement', and the subsequent challenges faced by researchers trying to evaluate a DBCI.

2.3 DBCI Evaluation

Just as there are numerous frameworks and processes for DBCI development, there are multiple frameworks for the evaluation process, including the 'The Health IT Usability Evaluation Model' (Health-ITUEM) (Brown III *et al.*, 2013), the 'MRC Process Evaluation Framework' (Moore *et al.*, 2015), or the APEASE criteria (Michie *et al.*, 2014b). All of these evaluation processes – like the development frameworks – measure the effectiveness of the DBCI.

'Effectiveness' in this context is defined as 'the effect size of the intervention in relation to the desired objectives in a real world context' (Michie *et al.*, 2014b, Table 1). Effectiveness is not the only important criterion during DBCI evaluation, but without it the other criteria are irrelevant (Michie *et al.*, 2014b). *Engagement* is a prerequisite for effectiveness (Yardley *et al.*, 2016b, p.833), which is why evaluating engagement should be a 'priority' within DBCI research (Perski *et al.*, 2017, p.254).

The following sections explore the challenges faced by engagement research and explain how a disengagement focus can benefit researchers by improving usage, increasing the DBCI's effectiveness.

2.3.1 Engagement Research

Unfortunately, there are many challenges to conceptualising, measuring, and evaluating engagement, which were touched upon in the introduction. Firstly, there is a lack of consensus around the definition of engagement and how it can be measured. Perski *et al.* (2017, p.258) have proposed the following definition of engagement with a DBCI: '(1) the extent (e.g. amount, frequency, duration, depth) of usage and (2) a subjective experience characterised by attention, interest and affect'. Perski *et al.* (2017, p.258) also suggest

that each aspect of this definition can be measured by the following three methods: 'user-reported interaction', 'automated recording of DBCI usage', and 'physiological or psychophysical' responses to DBCI usage. They claim that *in principle* each of these can be measured in *every* DBCI study. However, in reality this is unlikely to be the case. Physiological and psychophysical measures – such as cardiac activity and eye tracking – currently require both specialist equipment and software, as well as expert knowledge, money, and time. This is not always available to researchers, especially when engagement is not a primary research objective. As a result – especially when engagement is a secondary focus or is part of the evaluation process – many researchers oversimplify by making it synonymous to usage. Examples of this practice can be seen in research into smoking cessation (McClure *et al.*, 2013), diabetes (Alkhaldi *et al.*, 2017), physical activity (McCallum *et al.*, 2018), and mental health (Torous *et al.*, 2018). Inevitably, this leads to a misleading and inaccurate conceptualisation of engagement.

Secondly, even with the appropriate resources and technology, researchers may still struggle to measure engagement accurately or consistently. For example, Lalmas *et al.*'s definition of engagement emphasises its temporal component, 'at any point in time *and* over time' (2014, p.3). This temporal facet further complicates the collection of relevant and accurate data because the level of engagement is likely to change across sessions *and* within a single session. This prevents a consistent measurement of engagement levels, and could in part be explained by the user's 'affect' or 'attention'. For example, McCarthy & Wright (2004a) explain that emotion is linked inextricably to an individual's life-situation and their feelings about an object. This context of use is also likely to affect a user's attention levels. In addition, McCarthy & Wright (2004a, p.105) explain that an individual's interaction with technology is further influenced by their past experiences and personal standards. The DBCI cannot control these external factors that lead to engagement and therefore this research suggests that it is not possible to state that a DBCI will be engaging; it depends on an individual user and each instance of use. That is not to say that certain design features might not increase engagement – such as 'gamification' (Kappen *et al.*, 2017) or 'aversive feedback' (Kirman *et al.*, 2010) – but it is difficult to fully understand their long-term impact, their level of impact, or their impact on different members of the target population. For all the reasons stated above, it is difficult to reliably and accurately measure engagement in *every* DBCI study.

Behaviour Change researchers are ultimately interested in 'effective' engagement 'that mediates positive outcomes' (Yardley *et al.*, 2016b, p.835). However, as suggested above, there is still a lot that is unknown about engagement in terms of its quality and intensity, and how it might best and most accurately be measured. This thesis therefore presents a new approach – focusing on disengagement – that does not require specialist equipment but can help any researcher to better understand their target population's usage, motivations, and experiences with their DBCI. In light of these difficulties, this

thesis therefore presents a new approach that focuses on disengagement. This alternative approach is not limited by requiring specialist equipment or training. Instead it offers accessible help to any researcher requiring a better understanding of their target population's usage, motivations, and experiences with DBCIs.

2.3.2 Disengagement Research

The disengagement framework proposed in this thesis can be used to identify barriers to usage, explore and understand an individual's motivations, and also contextualise a participant's usage data. This will provide researchers with a more dynamic and effective tool to measure the success of their DBCI as well as provide recommendations for future iterations or research studies. This innovative proposal is not a new model or approach to development, but rather a tool which should be used within an established approach, such as the PBA or the CeHRes Roadmap. It will be accessible to all researchers and does not require specialist equipment nor training. In summary, it is intended to provide a tool for evaluating key aspects of any DBCI's design or adoption, but which does not rely on misleading conceptualisations of engagement as estimates of usage.

2.4 Summary

This chapter has set out some of the key components of a DBCI and presented three representative developmental approaches taken by researchers. There are numerous other frameworks and models but those described in Section 2.2 illustrate the different stages and processes taken during a development lifecycle. In addition, although the three approaches highlight different methodologies, each discusses the need to evaluate the DBCI, especially in terms of its effectiveness. Section 2.3 then defines 'effectiveness' and explains its relationship to 'engagement'. However, engagement research is not a straightforward task and presents a series of challenges to researchers. For this reason, this thesis presents a new tool to aid the evaluation process, the DisENGAGE Framework. This framework can be used by any researcher, in any research study to better understand users, the context of use, and the DBCI itself.

To create this disengagement framework it is important to understand the various components and facets of disengagement. The next chapter therefore explores (dis)engagement related terms to understand how these different research areas can guide disengagement research. It also introduces the two types of DBCI disengagement: behavioural and digital.

Chapter 3

Disengagement Terminology

Chapter 2 introduced the concept of disengagement and explained the benefits of researching this phenomenon as a form of evaluation for DBCI studies. However, there are also a number of other terms that relate to DBCI (dis)engagement. This chapter explores how these terms apply to disengagement research and the wider DBCI context.

It is important to establish non discipline-specific terminology to enable collaboration across disciplines and to ensure that terms are being used consistently within research communities. Without consistency of use, it is difficult to identify relevant disengagement-related research and draw comparisons between studies.

Researchers also often concentrate on a particular term, which creates silos of research (Sieverink *et al.*, 2017). This prevents researchers from building upon existing knowledge or contextualising their findings within the wider research community. It also fragments and impedes progress. This thesis aims to build upon the pre-existing knowledge by using research from these various silos to better understand the phenomenon of disengagement.

Section 3.1 explores the terminology relating to (dis)engagement within behaviour change literature. Section 3.2 explains the difference between the two key HCI silos of research – User Engagement (UE) and User Experience (UX) – to contextualise disengagement within this field.

The terms in this chapter explore particular facets of (dis)engagement from DBCIs and therefore a list of definitions is proposed, which will be used for the remainder of the thesis. Furthermore, Section 3.3 presents a taxonomy of disengagement-related terminology, which contextualises the terms across research silos and disciplines. This addresses RA1: to provide an overarching vocabulary for disengagement research with DBCI.

3.1 Behaviour Change Terminology

This section explores the confusion around disengagement-related behaviour change terminology. There seem to be three main reasons why a single term can be used to describe different actions or events. This section will explore these, using examples to produce a definitive list of definitions. These definitions will be used throughout the remainder of the thesis.

3.1.1 Defining the Focus of Disengagement and Related Terms

Digital behaviour change research has two points of failure or success, (dis)engagement with the intervention content itself – i.e. the strategies and the content – and usage of the technology. This thesis will refer to disengagement with the content as 'behavioural disengagement' and non-usage of the technology as 'digital disengagement'. These different points of focus – technology and content – are not always made explicit, possibly because pre-digital definitions are being used within a DBCI context. This issue leads to confusion and can occur with all of the disengagement-related terms.

Kelders *et al.* (2012) define adherence as the 'proportion of participants who use the intervention as it is intended to be used', and intended usage as 'the extent to which the developers of the intervention felt that the intervention should be used to achieve the desired effect'. The intended usage should be set by the designer and if followed should provide the maximum benefit to the user from the intervention (Kelders *et al.*, 2012). However, intended usage does not always draw a distinction between the behavioural and digital aspects and therefore it is unclear what the individual is adhering to. For example, an individual could *use* the intervention as intended (digital adherence) – e.g. opening the app for 20 minutes a day, but if they are not actively using or applying the guidance to their daily lives (behavioural adherence), their behaviour change attempt may be unsuccessful.

In addition to the two points of focus – behavioural and digital – DBCI research terms can also relate to aspects of an individual's participation in the study. The confusion surrounding a term's focus or subject led to Eysenbach's (2005) significant paper on the 'law of attrition'.

Attrition research originally referred to 'the phenomenon of participants stopping usage and/or being lost to follow-up'. Again these two concepts are very different. Stopping usage of the DBCI may mean they are still engaging with the behavioural aspects but not the digital, or they may have disengaged from both. However, a participant may engage with the DBCI on a behavioural and technological level but disengage from the research study and not complete the follow-up questionnaires. These two situations will have very different impacts on their behaviour change attempt and therefore additional data

and descriptive terminology are required. For this reason Eysenbach (2005) introduced two terms: 'non-usage attrition' – which is self-descriptive as non-usage of the digital – and 'dropout attrition' which refers to an individual who has left the study before the follow-up questionnaires (Eysenbach, 2005).

3.1.2 Reporting Data

Issues also arise when researchers use different methods of reporting; either utilising continuous or categorical data. Continuous data provides a rate over time. For example, Eysenbach (2005) proposed a non-usage attrition curve which starts at 100% participation and shows the decrease of participation over time.

However, non-usage attrition data can also be categorised. For example, Reinwand *et al.* (2015) reported non-usage attrition by grouping the users as either using or not using the intervention. However, categorical data requires a threshold point to compare the usage against – similar to intended usage. This value is likely to be intervention-specific making comparisons across research projects almost meaningless.

In addition, researchers often want to provide a value of adherence or attrition at different stages of the study – such as 3-, 6-, 9-months (Couper *et al.*, 2010) – which requires a categorical approach. However, reporting usage in this way can reduce the value and detail of the findings. Categorical non-usage attrition results in a group of 'users' and 'non-users'. The non-user group includes participants that did not reach the usage threshold. However, this group will also contain individuals that had no usage and those that may have had multiple periods of usage – but possibly sporadic use – depending on the threshold value.

3.1.3 Colloquialisms

There is often a difference between the context-specific definition and the colloquial use of a term. For example, dropout is used colloquially to describe a loss of an individual from a group or a school etc. However, Eysenbach (2005) uses the term 'dropout attrition' to specifically refer to the loss of a participant before the follow-up questionnaire. Research relating to disengagement will not always use a follow-up questionnaire and therefore 'dropout attrition' could refer to the loss of a participant before the final point of data collection.

Colloquially, 'engagement' and 'disengagement' are understood to be the antithesis of one another. However, this is only true using a categorical approach to data. If engagement is reported using a continuous approach, at what point does disengagement occur? Does disengagement occur at a particular point or are there low levels of engagement and

then none? Furthermore, according to O'Brien & Toms (2008, p.948-949) engagement is a process whilst disengagement is a part of that process rather than an opposite.

Similarly, Kuniavsky (2003, p. 412) uses retention to describe whether an individual returns to a website after the first visit. This usage is similar to the colloquial use of a phrase like 'holding on to something or someone'. However, Couper *et al.* (2010) have a specific definition of retention as the 'completion of follow-up surveys 3-, 6-, 12-months after baseline'; i.e. the opposite of dropout attrition. These multipurpose words can cause confusion in articles and journals when it is unclear which meaning the author is using.

3.1.4 Definitions of Terms Used in this Thesis

A DBCI requires a level of *engagement* with both the digital and the behavioural strategies. Each of the disengagement-related terms therefore has to reflect this multi-layered research focus. In addition, this type of research appears to report using two distinct approaches: continuous and categorical. To better understand research in this area, it may be beneficial to clarify the different approaches to reporting data, and in the case of categorical reporting, the fact that researchers must specify the threshold value. It is also important to be aware of the colloquial use of terms and therefore define terminology before use.

This research will use the following definitions.

Adherence: the extent to which an individual or group of individuals use an intervention, in relation to the expected or intended use.

Disengagement: the termination or non-usage of a DBCI.

Dropout: the loss of an individual or group of individuals from the study.

Dropout attrition: an individual or group of individuals that dropout before the final point of data collection.

Intended usage: the desired amount (set by the intervention designer) of exposure an individual should have to an intervention.

Non-usage attrition: an individual or group of individuals that stop using the intervention technology.

Retention: an individual or group of individuals that did not dropout.

Retention rate: the number of participants that complete the follow-up questionnaire or final point of data collection.

3.2 Human-Computer Interaction Terminology

To contextualise disengagement within HCI it is important to understand the relationship between User Engagement (UE) and User Experience (UX). Each term has its own research community and there is a lack of consensus amongst researchers regarding scope, perspective, and measurement. Numerous papers attempt to explain the different aspects and tensions within the fields of User Engagement (UE) and User Experience (UX) without providing definitive answers (e.g., for UE: O'Brien & Toms, 2008; Peters *et al.*, 2009; Lalmas *et al.*, 2014; O'Brien, 2016; for UX Hassenzahl & Tractinsky, 2006; Law *et al.*, 2009; Roto *et al.*, 2011; Bargas-Avila & Hornbæk, 2011; Lallemand *et al.*, 2015). However, there are definitions that more clearly separate the two fields of research. For example, Lalmas *et al.* (2014) uses Hassenzahl & Tractinsky's (2006) UX definition to distinguish UX from their definition of UE.

> Hassenzahl & Tractinsky (2006, p.95) define UX as a 'consequence of a user's internal state (predispositions, expectations, needs, motivation, mood, etc.), the characteristics of the designed system (e.g. complexity, purpose, usability, functionality, etc.) and the context (or the environment) within which the interaction occurs (e.g. organisational/social setting, meaningfulness of the activity, voluntariness of use, etc.).'

> Lalmas *et al.* (2014, p.3) define UE as 'the *emotional*, *cognitive*, and *behavioral* experience of a user with a technological resource that exists, at any point in time *and* over time.'

Using these definitions, Lalmas *et al.* (2014) suggest that UE focuses on the three aspects of an experience – emotional, cognitive, and behavioural – whereas UX research is focused on a specific interaction at a specific point in time. This approach conflicts with Sutcliffe (2016, p.105) who suggests that UX is the bigger picture, which investigates the adoption and usage of a technology over many sessions or even years, whereas UE focuses on attracting users within a session (e.g., by making the interaction fun and exciting). O'Brien & Toms's research (2008, p.946) also suggests that *engagement* should be considered as a *quality* of an experience rather than a type of interaction.

The following sections briefly explore modelling, time, and related theories, to try to separate and conceptualise these areas of research.

3.2.1 Modelling User Engagement (UE) and User Experience (UX)

There is a difference – in both fields – between defining the phenomenon and attempting to measure it. The kinds of definitions referred to above attempt to separate UE and

UX. However – as the models in Chapter 5 will illustrate – these research areas often cite the same or similar model attributes or measurements and yet they focus on slightly different aspects of the interaction.

Lalmas *et al.* (2014) state three ways of approaching UE research: a focus on the user, the positive aspect of the UX, or the ability of the system to 'capture' or create UE. Here Lalmas *et al.* (2014) report that UE is the positive aspects of the UX. However, in all three approaches the user has a key role to play in the interaction and this makes the job of designing a good UX or UE incredibly challenging.

Some models of UE focus on the attributes of engagement, as a process independent of the individual – such as the 'Model of Engagement' (O'Brien & Toms, 2008, p.949), whilst others focus on the user and their role in the interaction – such as the 'Model of Cognitive Factors Influencing User Engagement' (Sutcliffe, 2016, p.110). Hassenzahl's (2005, p.32) 'Model of User Experience' focuses on the attributes of the technology and the impact of these on the user. However, the same or similar attributes are listed in both UE and UX models – such as 'interactivity', 'judgement', and 'usability' – and therefore attributes do not by themselves differentiate between the two research fields.

Models in both the UE and UX area – such as the 'Model of User Engagement in Online Interventions' (Short *et al.*, 2015, p.34) or the 'Threads of Experience' (McCarthy & Wright, 2004b, p.83) – include the 'affective' or 'emotional' impact of the user on an interaction, again failing to differentiate between the two research focuses. However, these aspects do make designing for a good UE and UX very demanding; not least because a user's mood and emotional state are not always consistent. A user may respond differently to the same design, given in a different environment or different emotional state. Therefore researchers face similar design challenges.

3.2.2 Time

The different time-frames associated with the concepts of UE and UX are another factor that is not clearly differentiated in the research. O'Brien (2016) discusses the issue of temporality and the various approaches researchers use to conceptualise UE, including discussions of such terms as: 'within a session', 'continued use', 'short term and long term re-engagement', and 'intention to reuse'. Lalmas *et al.* (2014) also differentiate between periods of engagement using terms such as 'inter-session' engagement (meaning across multiple sessions), and 'intra-session' engagement (meaning within a single session). Equally, Roto *et al.*'s (2011) propose four different types of UX: 'anticipatory', 'momentary', 'episodic', and 'cumulative' (see Figure 3.1). It therefore appears that both the terms UE and UX can refer to real-time interactions and interactions with a technology over a sustained period.

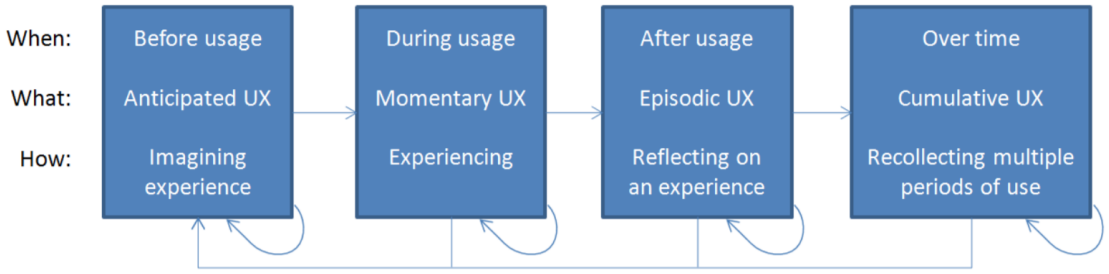

Figure 3.1: 'Time spans of UX' taken from Roto *et al.* (2011)

3.2.3 Related Theories

One differentiating factor between UE and UX is their related theories. UE is often associated with the 'Theory of Flow' (Csikszentmihalyi, 1997). O'Brien (2016, p.10) lists the characteristics of Flow as 'enjoyment, challenge, intrinsic motivation, focused attention, positive reinforcement, clear goals, personal control, and temporal dissociation'. These overlap with a number of UE model attributes, including 'challenge', 'focused attention', and 'motivation' (O'Brien & Toms, 2008, p.949). Potentially linked to this idea, O'Brien (2016, p.22) refers to UE as a continuum from 'shallow' to 'deep' levels of interaction. This continuum is one of the factors that makes UE difficult to measure; it is unclear what constitutes the different levels. UX on the other hand is not associated with the 'Theory of Flow' nor this intensity of interaction. There is also not a clear link between engagement and experience. UX does not necessarily generate a high level of UE and equally high UE does not necessarily result in a good UX (Lalmas *et al.*, 2014, p.3). Users may use technology to complete a task or to fulfil an intrinsic motivation without the need for Flow-like 'engagement'.

3.2.4 Summary

There are clearly a number of overlapping concepts that confuse UE and UX research. Using Sutcliffe's (2016) and O'Brien & Toms' (2008) definitions, DBCI designers should possibly focus more on the UX aspects – the longer term usage factors – rather than specifically focus on the *level* or instances of engagement. However, if *engagement* is a quality of UX it is important for researchers to consider UE and UX factors to identify as many potential factors for disengagement as possible.

3.3 A Taxonomy of Disengagement

Disengagement with DBCI involves an understanding of the digital usage and the adoption of the strategies and content. For this reason, I propose three new terms to better distinguish aspects of (dis)engagement across the Behaviour Change and HCI fields:

Digital Disengagement: when a participant decides to stop using the intervention technology, or when factors in the participant's external environment cause them to cease using the technology.
Indication: Digital adherence, Non-usage attrition, User Engagement, User Experience

Behavioural Disengagement: when a participant decides to stop using the intervention content material, or when factors in the participant's external environment cause them to cease following its guidance.
Indication: Behavioural adherence

Digital-Behavioural Disengagement: when a participant decides to stop using the intervention technology and content material, or when factors in the participant's external environment cause them to cease.
Indication: All of the above

The following taxonomy proposes how the disengagement-related terms fit in the wider context of disengagement and how these can help measure and explain aspects of a DBCI study (see Figure 3.2).

The taxonomy separates measures or terms linked with the digital elements and the behaviour change content. Digital disengagement focuses on cessation of technology usage and therefore this segment includes the terms that relate specifically to the digital aspects. Non-usage attrition records the number of users over time, focusing on usage logs provided by the technology (relating to digital disengagement). Adherence will normally relate to the behavioural aspects. However, digital adherence refers to an intended usage that specifies an amount of DBCI usage.

Behavioural disengagement focuses on the point at which an individual ceases to follow the intervention guidance. Behavioural adherence determines whether an individual is implementing the behaviour change content in accordance with the intended usage value (relating to behavioural disengagement).

Categorical- and continuous- reporting can be used for any of the terms discussed. Therefore, these can be digital or behavioural, depending on the term it prepends.

Dropout attrition specifically relates to the study; reporting the number of participants that complete the follow-up questionnaire. Behavioural and digital disengagement cannot necessarily predict dropout attrition rates. An individual could complete the entire programme (behavioural) and use the DBCI (digital) but not complete the follow-up questionnaire. Therefore, this value relates more directly to the study participation than the intervention success. However, this value is important because it provides context for the feedback, explaining how representative it is of the study population. It does require a different segment on the taxonomy, indicated as 'Research Study Participation'.

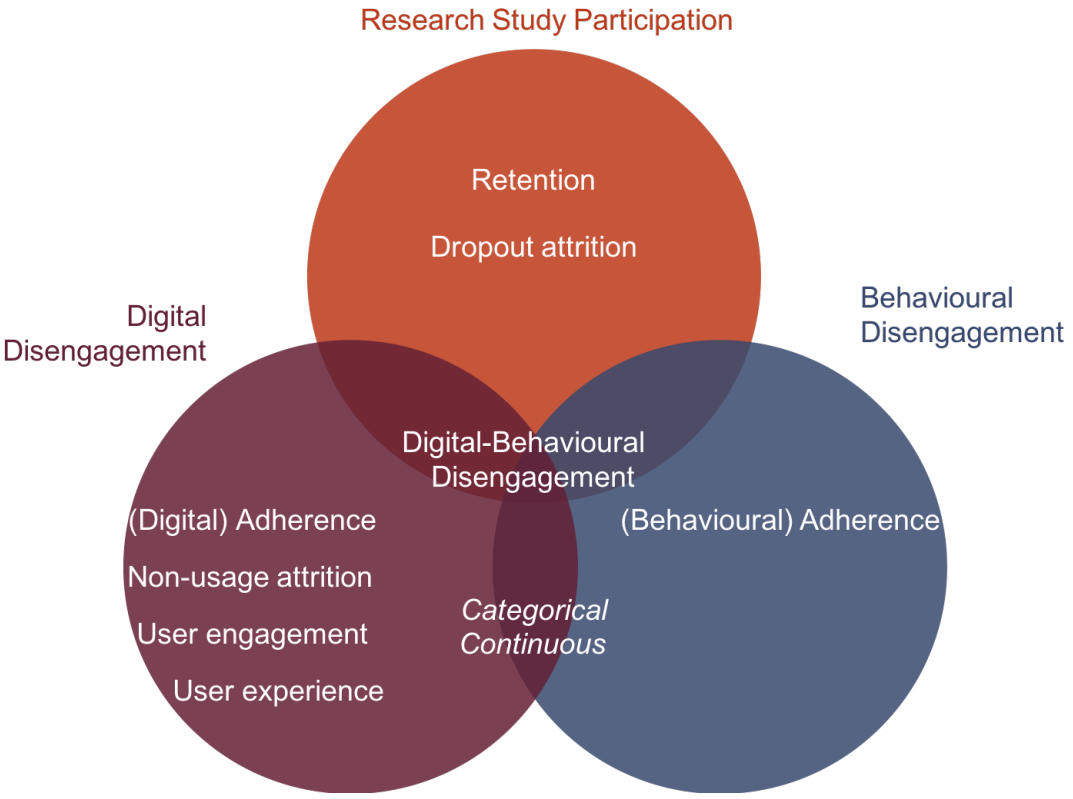

Figure 3.2: A Taxonomy of Disengagement

As previously discussed, 'Digital-Behavioural Disengagement' can use adherence and non-usage attrition rates as indicators for disengagement and therefore it sits in the intersection between 'Digital' and 'Behavioural' segments. Digital-behavioural disengagement probably would fit here in a non-research setting. In that context, the taxonomy would not have a 'Research Study Participation' segment. However, disengagement research requires data from the follow-up questionnaires. This research needs to identify the factors that lead to a user either becoming digitally disengaged, behaviourally disengaged, or both (digital-behavioural disengagement). The majority of this data is gathered at the follow-up stage of a study and the dropout attrition rates provide a record of the number of individuals who contributed to this evaluation assessment. Therefore, digital-behavioural disengagement should be positioned in the centre of the taxonomy, utilising each segment and their respective indicators: adherence, non-usage attrition, dropout attrition, UE, and UX.

Framing disengagement as a compound of these three elements provides signals and evidence of when a user is not complying with an intervention. However, it is also important to consider all these elements separately before describing a user as being 'fully' disengaged. Depending on the study design, it may not be possible to tell whether an individual is adhering or behaviourally-engaged without the follow-up data. For research purposes, it is also necessary to collect data from all three segments so that the community can start to explore this phenomenon of disengagement more effectively.

Chapter 4

Behaviour Change Models and Disengagement

Chapter 3 presented a taxonomy of disengagement-related terms by exploring the terminology from Behaviour Change and HCI literature. This taxonomy links related research terms and explained how these can provide insights into disengagement.

Disengagement is currently not explored within DBCI research and therefore it is not possible to conduct a literature review of disengagement models or factors. Instead, research needs to explore disengagement-related terms which will allow the creation of a framework (RA2) that addresses the behavioural and digital aspects of the phenomenon. For this reason, the following literature review uses a 'purposive sampling' method, specifically 'maximum variation' sampling (Palinkas *et al.*, 2015, p.535-536).

'Purposive sampling' can be used to ensure variety in a sample, specifically focused around a key research question (Bryman, 2012, p.418). In particular a 'maximum variation' sampling can be used to provide a holistic exploration of a phenomenon across diverse contexts (Suri, 2011, p.68). Disengagement from health-related DBCIs requires an understanding of behaviour (behavioural disengagement), behaviour change factors (behavioural), use of technology (digital), and the use of DBCI (digital-behavioural disengagement).

This chapter explores models from the Behaviour Change literature, including health-related models of behaviour, behavioural interventions, and adherence. It critiques existing models and identifies relevant factors of disengagement. Section 4.1 analyses the models of behaviour and behavioural interventions to identify factors relating to the behaviour change process (behavioural disengagement). Section 4.2 examines digital behavioural intervention models specifically to identify any further disengagement factors that emerge when using technology (digital-behavioural disengagement).

In this chapter the term 'model' will be used as short-hand to represent models and frameworks. These terms are often used interchangeably but this will be explained in more detail in Chapter 6.

At the end of each section, there will be a table of identified factors, generated from the discussed models. Chapter 5 will follow a similar process to identify disengagement-related factors from HCI: adoption, User Engagement (UE), and User Experience (UX). These tables will be used to create the disengagement framework which is presented in Chapter 6 (RA2).

4.1 Behaviour and Behavioural Intervention Models

This section analyses two health-related behaviour models and three adherence models, which were identified during the adherence research from Chapter 3: 'Health Belief Model' (HBM) (Rosenstock, 1974), an 'Integrative Model' (INT) (Fishbein, 2000), 'Information-Motivation-Strategy Model' (IMS) (DiMatteo *et al.*, 2012), 'Predictors of Psychosocial Treatment Non-Adherence' (PPTNA) (Gearing *et al.*, 2014), and 'Working Model Theory to Illustrate the Experience of Non-Adherence' (WMTENA) (Johansson *et al.*, 2015).

HBM was included in this section because it is one of the most widely used models within health-related behaviour research (Champion & Skinner, 2008, p.45), and many of the later models refer to concepts which it explores, such as perceptions and beliefs. For example, DiMatteo *et al.*'s (2012) IMS Model draws heavily upon HBM. The 'Integrative Model' (INT) (Fishbein, 2000) is a hybrid model of leading health-related theories, and gives an overview of health-specific factors that explain why a behaviour is carried out. It also provides insight into behavioural disengagement.

The following three adherence models were identified through a series of Google Scholar literature searches. Each search included the terms 'behaviour change' (or 'behavior change') AND 'health' AND 'model' (or 'framework'), plus a specific term relating to disengagement such as: 'adherence' or 'non-adherence' (or 'nonadherence'). Models were only selected if they had been published during the period 2009-2015 and if the publication included a definition of the disengagement specific term.

DiMatteo *et al.*'s (2012) 'Information-Motivation-Strategy (IMS) Model' was developed and validated using evidence from empirical meta-analytic reviews and large-scale trials into adherence. This meta-analytic review identifies aggregate trends in adherence (DiMatteo *et al.*, 2012), and offers a range of representative factors which may be linked to behavioural disengagement.

Gearing *et al.*'s (2014) 'Predictors of Psychosocial Treatment Non-Adherence' (PPTNA) was generated from a comprehensive review of adherence which included three key areas: psychosocial treatment, mental health, and adherence (Gearing *et al.*, 2014, p.32). Mental health issues (such as depression) have been linked to higher rates of risky health behaviours (such as smoking or obesity) which DBCI often target (Katon, 2003, p.218).

Johansson *et al.*'s (2015) 'Working Model Theory to Illustrate the Experience of Non-Adherence' (WMTENA) research conducted interviews with non-adhering patients. This model's focus on non-adherence and the use of qualitative data makes it particularly relevant to this review.

These adherence models compare the use of (non-technological) intervention to the intended intervention usage and therefore can provide insight into factors for behavioural disengagement. Although Johansson *et al.*'s (2015) model was based on an Internet intervention, the model did not aim to address any of the digital aspects of the design, instead it focuses on non-adherence and therefore was included in this section.

The evolution from traditional to digital interventions will not necessarily eliminate the factors that affect adherence to pre-digital interventions. The newer, digital presentation of content may have just transferred pre-existing disengagement factors to this new format. For example, rather than finding it difficult to schedule a face-to-face appointment, an individual might find it difficult to schedule time for the digital intervention session. The models in this section can therefore provide potential factors for behavioural disengagement.

4.1.1 Health Belief Model (HBM)

The 'Health Belief Model' (HBM) was originally constructed to explain why individuals avoid behaviours that are believed to help prevent the development of a disease (Rosenstock, 1974). HBM suggests five components that influence the likelihood of whether an individual will carry out health-related action or behaviour: 'perception of threat' (combining susceptibility to and severity of disease), 'perception of benefits', 'perception of barriers' (to act), 'cues to action', and 'self-efficacy'[1]; although this final component was not included in the original model) (Champion & Skinner, 2008). In addition, these perceptions are modified by a number of demographic factors including: 'age', 'gender', 'ethnicity', 'personality', 'socioeconomics', and 'knowledge'.

HBM explains that these factors can be interdependent. For example, the 'perceived threat' is the combination of 'perceived susceptibility to and severity of disease' (ie., whether the individual feels it is likely that they will contract the disease and the severity of consequences if they did). Just analysing one of these (such as susceptibility) might

[1]Defined as 'confidence in one's ability to take action' (Champion & Skinner, 2008, p.48)

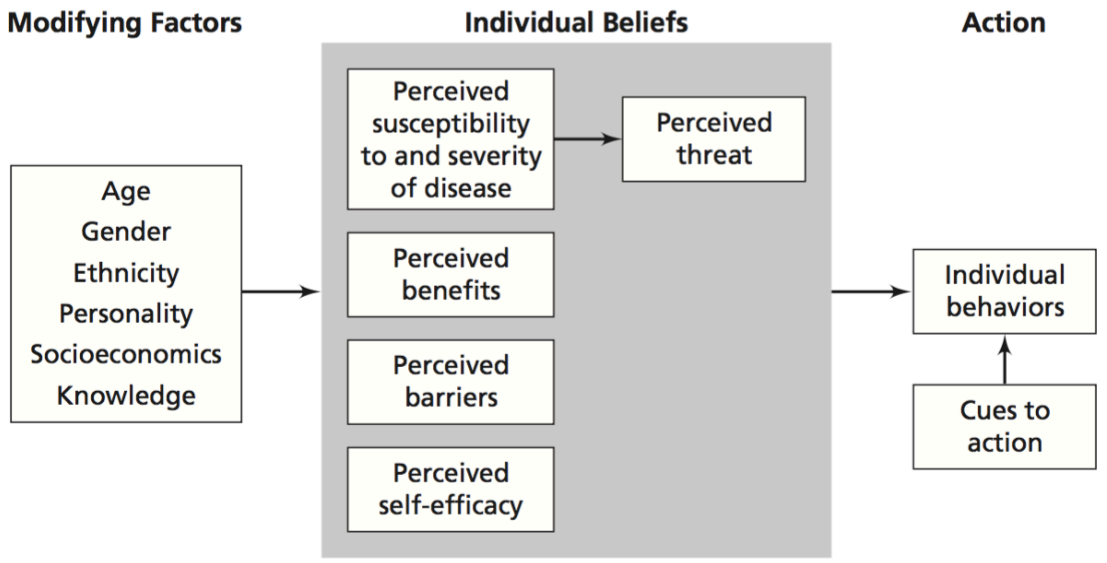

Figure 4.1: 'Health Belief Model (HBM)' taken from Champion & Skinner (2008, p.49)

lead to misleading results and conclusions. Disengagement research should also be aware of potential dependencies between factors. For example, a lack of technical skills may not be a barrier to usage if the user has additional support from friends or family.

This model also highlights the impact of beliefs and perceptions on behaviour change. This is an important consideration within research because it is not just the barriers or benefits but the user's perceptions of these. For example, an individual may be capable of using a DBCI but if it appears complex they may doubt their ability or 'perceived self-efficacy'.

There are some limitations to the HBM. Firstly, it has been criticised for failing to consider the emotional impact of behaviours or ill health. For example, research has found fear and HBM constructs to be linked (Champion & Skinner, 2008, p.62) but this is not reflected in the original model. Therefore disengagement research must look at additional models or theories of behaviour to fully understand behavioural disengagement.

Secondly, it is not always clear how to measure some of these HBM factors, especially in a DBCI context. For example, after a period of inactivity an individual logs into a stop smoking intervention; this occurs after they have a bout of coughing – a physiological trigger – and they receive a notification on their phone from the app – a technological trigger. It is difficult to ascertain which trigger was their 'cue to action' or whether it was a combination of the two. It is therefore difficult to identify what had the significant impact on motivating the individual to act at that moment in time (Champion & Skinner, 2008, p.49).

This model can inform disengagement research in a number of ways. The model states a number of factors that effect whether a behaviour is performed (such as perceived benefits, barriers, and self-efficacy), providing insight into potential behavioural disengagement. In addition, it highlights that factors may be linked and therefore it is important to ensure that as much contextual data is collected as possible and that individuals are given the opportunity to provide further explanation regarding a disengagement factor. Furthermore, it is important to understand the individual's perceptions or beliefs relating to the desired behaviour and the DBCI.

4.1.2 Integrative Model (INT)

Fishbein's (2000) work provides an integrative model of the leading theories of behavioural prediction and change, including the 'Theory of Reasoned Action' (TRA) (Ajzen & Fishbein, 1980), 'Social Cognitive Theory' (Bandura, 1986), and the 'Health Belief Model' (HBM) (Rosenstock, 1974) (see Figure 4.2).

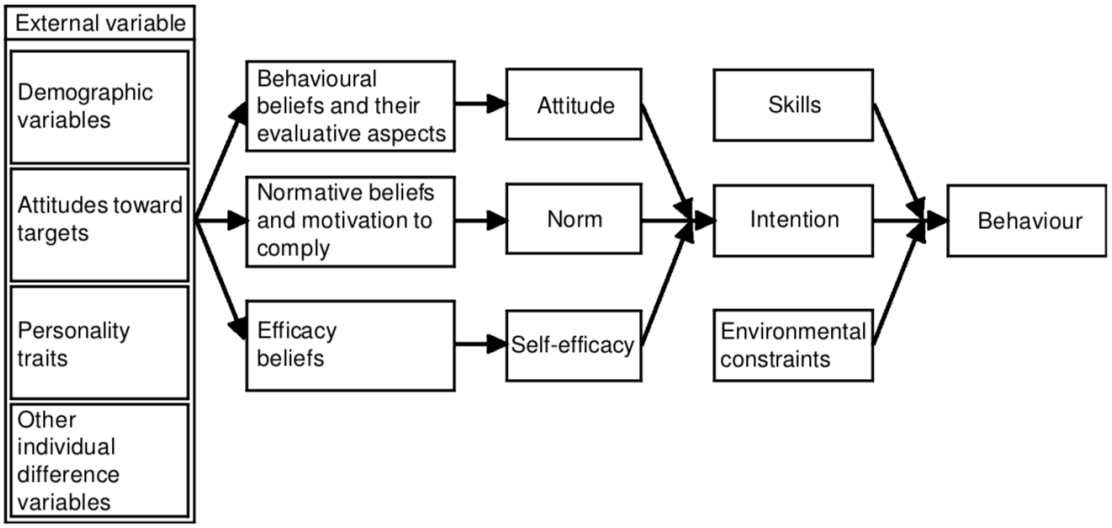

Figure 4.2: 'Integrative Model' taken from Fishbein (2000, p.274)

The model states that an individual is very likely (with a probability close to one) to carry out a behaviour if they have the 'skills', if there are no 'environmental constraints', and if they have a strong 'intention' to perform the behaviour. An individual's 'intention' results from their 'attitudes', 'norms', and 'self-efficacy'. An individual will make a judgement as to whether they think the outcome of performing a behaviour is predominantly favourable or not. 'Norms' include an individual's perception of what they think other people think they should do, and their perceptions of what other people are doing. 'Self-efficacy' is the individual's belief in themselves regarding their ability to perform the behaviour.

Finally there are a number of external variables that feed into 'attitudes', 'norms', and 'self-efficacy'. These include 'demographic variables', 'attitudes towards targets',

'personality traits', and 'other individual difference variables' (such as perceived risk) (Fishbein, 2000, p.276). The 'attitudes toward targets' in Fishbein's case refer to condom use, as their specific research was exploring the role of theory in HIV prevention (2000, p.274). However, more generally this term would refer to the desired behaviour or treatment encouraged by the DBCI. Additionally, it could refer to the DBCI itself.

Fishbein (2000, p.275) explains that the variables discussed in this model have been tested in over 50 countries and therefore they are confident that it can be applied to any population. However, they also stress that the variables will have different levels of importance depending on the population and the specific behaviour being addressed.

This integrative model provides a useful overview of the various factors relating to behaviour change and additionally how intention translates into the performance of a behaviour. However, it was not intended to address the use of digital interventions or the additional factors that this new context might present, thus limiting the factors to the behavioural rather than digital aspects of disengagement. For example, the 'environmental constraints' refer to the barriers to behaviour change, but environmental barriers may also affect the use of a DBCI. Additionally, it is not clear what the model means by 'individual difference variables' as Fishbein (2000, p.275) only provides one example.

This model has a number of implications for a disengagement framework. It emphasises the importance of the individual – and their traits – on the process. In addition, it explains the importance of the individual's beliefs and attitudes during behaviour change. A user must have a strong behavioural intention but in addition must have the skills and the correct environmental context to carry out the desired behaviour.

Fishbein's research (2000) also emphasises the importance of the population and the specific behaviour being addressed. A disengagement framework needs to be adaptable for different behavioural contexts; providing guidance for the multitude of factors that can affect disengagement.

4.1.3 Information-Motivation-Strategy Model (IMS)

The 'Information-Motivation-Strategy Model' (IMS) was developed from a literature review of adherence to medical behaviours and advice (DiMatteo *et al.*, 2012). It additionally draws from the 'Health Belief Model' (HBM) (Rosenstock, 1974) and the 'Theory of Planned Behaviour' (TPB) (Ajzen, 1991). As the name suggests, the model is comprised of three components: 'Information', 'Motivation', and 'Strategy'.

The 'Information' component states that patients can only carry out the desired behaviour if they understand what it is and how it can be accomplished (DiMatteo *et al.*, 2012, p.78-81). The 'Motivation' component explores various potential factors that can

either motivate or demotivate a patient. DiMatteo *et al.* (2012, p.81-83) mentions several models for motivation but draws heavily on HBM. Motivational factors include the individual's perception of treatment and their illness, therapeutic alliance, and cultural and environmental influences (DiMatteo *et al.*, 2012, p.81-83). Finally the 'Strategy' component seeks to identify and address any barriers to adherence. Issues relating to non-adherence at this level include overcomplicated regimens, the inconvenience of behavioural changes, any embarrassment caused by the treatment, and unpleasant side effects of taking the medication (DiMatteo *et al.*, 2012, p.84-86).

This model explains that an individual must know what they are required to do, when they are required to do it, and for how long. In a traditional setting, the model states that patients must believe in their treatment through discussions and co-development with their clinician. In a DBCI setting this might expand to a belief in the treatment program (intervention content) and the technology (intervention itself). It is unlikely that there will be the resources for one-to-one support through the DBCI and therefore the design must offer a user the required guidance and support to feel confident and motivated about their treatment programme. In addition, an individual needs to be aware of the potential consequences of behaviour change or medication adherence and provided with strategies to overcome these barriers. This model provides guidance for the type and structure of DBCI content.

The concept of 'support' appears in two separate components – 'Motivation' and 'Strategy' – although it takes a slightly different form in each. Social support is discussed in a practical form – relating to assistance – whereas emotional support encourages motivation. Support can therefore take various forms and this should be considered when investigating digital and behavioural disengagement.

Using the IMS Model within DBCI development or analysis is limited by its broad structure. Its overarching character is due to the fact that it was originally designed to support clinicians working alongside patients to improve adherence and therefore it lacks detail as a tool for designing a large-scale DBCI. For example, factors under the 'motivation' component range from perceptions of treatment to environmental influences. It is also unclear what impact the digital format will have on the therapeutic alliance and other aspects of the model, so these need to be explored with DBCI disengagement.

The IMS Model presents some interesting barriers and issues which prevent an individual from adhering to an intervention, i.e. behavioural disengagement. Collecting data relating to an individual's support network, including perceptions and practical support, can provide a new dimension to disengagement research. Additionally, the model emphasises the importance of good communications between the individual, health professional and researcher. This is imperative for addressing potential concerns and barriers identified by the individual. Within a DBCI context this might involve a FAQs section and a contact page to support this type of interaction. It might also be interesting to ask disengaged

individuals about any conversations they may have had with health-professionals or researchers and how satisfied they were with these interactions. As a result, although this model is broad, it does provide a lot of potential factors for disengagement.

4.1.4 Predictors of Psychosocial Treatment Non-Adherence (PPTNA)

Gearing *et al.* (2014) specifically focused their research of non-adherence within a psychosocial treatment context. This comprehensive literature review of adherence generated the following model for non-adherence (see Figure 4.3). Factors were grouped into five main categories, with various overlapping components: 'client', 'family', 'agency', 'environmental', and 'clinical'.

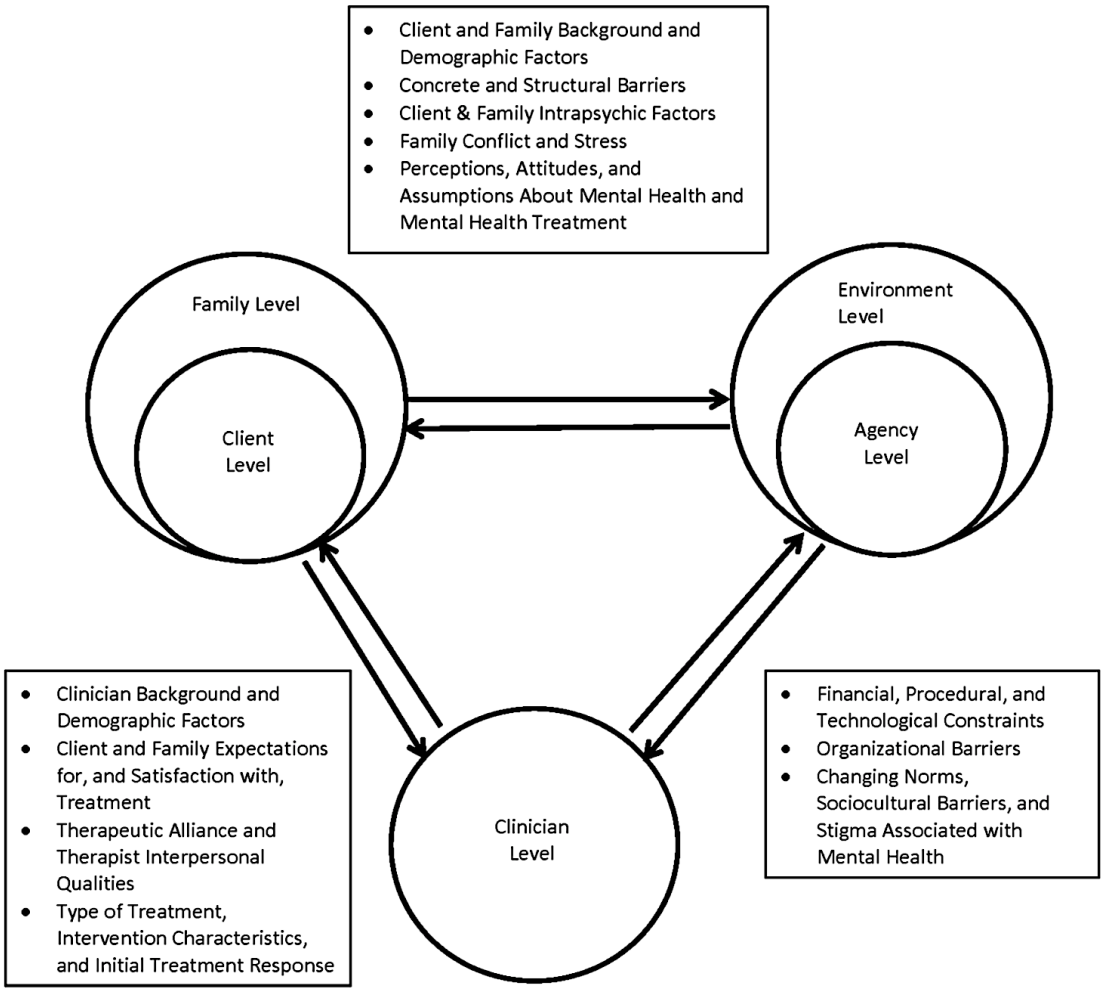

Figure 4.3: 'Predictors of Psychosocial Treatment Non-Adherence' taken from Gearing *et al.* (2014, p.37)

The 'client level' – also referred to in-text as the 'individual level' – lists research relating to 'demographics', 'concrete and structural barriers' (scheduling demands, lack of transportation and time management), 'intrapsychic barriers' (anger, forgetfulness,

degree of psychopathology), and 'intrapsychic factors' (perceptions, attitudes, and assumptions) (Gearing *et al.*, 2014, p.34-38). The 'family level' – surrounding the 'client level' – includes family level demographics such as single parent households, parental stresses, childcare issues and multiple children receiving treatment (Gearing *et al.*, 2014, p.38).

The 'agency level' considers the factors relating to the service providers. These include but are not limited to 'funding (affordability)', 'procedures (scheduling difficulties)', 'accessibility', 'linguistic barriers', and a patient's lack of 'insurance and agency location' (Gearing *et al.*, 2014, p.38-39). The interlinked 'environmental level' factor lists some considerations which could influence DBCI disengagement such as 'changing social norms', 'socio-cultural barriers' and 'opinions of social network members' (Gearing *et al.*, 2014, p.39). However, some of these factors may be at a societal level and beyond the reach of a single DBCI. Although, a DBCI design may not be able to influence at a societal level, a disengagement researcher should nonetheless be aware of these influences.

The final grouping is the 'clinician level', which considers the 'demographic characteristics' of the healthcare professional and the impact of these and other factors – such as 'experience' and 'education' – on their relationship with the patient, also known as the therapeutic alliance (Gearing *et al.*, 2014, p.38).

This model identifies that the relationship between clinician and patient – the therapeutic alliance – is very important and can significantly influence non-adherence. Research suggests that a discussion between these individuals should occur to ensure realistic expectations are set on both sides. A clinician has to consider the client's lifestyle, past experience, and fully explain the benefits and potential side effects of the intended treatment plan (Gearing *et al.*, 2014, p.38). In many cases, a DBCI aims to replace the face-to-face time with a clinician and therefore the responsibility for setting expectations and clearly communicating the plan may fall directly onto the DBCI. A poorly communicated treatment plan coupled with the lack of opportunity for discussion could cause disengagement, and therefore these factors need to be considered within a DBCI design. Other factors such as 'linguistic barriers' or 'time management' may also need to be reframed for a DBCI. For example, 'linguistic barriers' may present a barrier for DBCI content rather than during communication with healthcare professionals, and 'time management' may impact DBCI usage rather than scheduling an appointment.

This model is limited within the DBCI context as it does not focus on digital interventions and is focused on psychosocial treatments. As a result some of the factors need to be reconsidered and explored within a DBCI context. For example, this model highlights new factors relating to the individual which move beyond the commonly cited 'demographic' variables and 'beliefs'. However, rather than focusing on the negative 'intrapsychic barriers' – such as forgetfulness, anger, and self-destructive behaviour

(Gearing *et al.*, 2014, p.37) – these could be relabelled as 'emotions'; a concept which is absent in many other adherence models and yet has been linked to health-related behaviour (Champion & Skinner, 2008, p.62).

Other factors may need to be disregarded due to their irrelevance in the DBCI context. For example, 'lack of transportation' or 'insurance and agency location' are not as relevant for DBCI as digital interventions attempt to remove these geographic constraints. Other 'agency level' factors – such as 'affordability' – may also be less applicable for the UK based research context because these costs tend not to be a participant's responsibility.

The model was designed to aid clinicians' exploration of non-adherence factors. This explains why some of the groupings may not appear the most logical. For example, there seems to be an overlap between 'family level' and 'environmental level' factors – such as 'support' and 'opinions of social network members'. These may not refer to the same thing; the opinions of social network members could be negative and therefore not be supportive. However, these two factors refer to the same group of individuals; i.e., the social network of the individual. For a researcher, it might be better to consider these distinctive behaviours by the support network as *people*, who can influence the individual rather than as compartmentalised behaviours. This highlights the importance of factor grouping. A disengagement framework needs to group factors in a way that helps researchers in their data collection.

This model presents several high-level and specific factors relating to non-adherence with a psychosocial context. Some of these factors are too specific and therefore not relevant for the disengagement framework. However, several factors might need to be reframed for a DBCI setting. In addition, this model emphasises the importance of the therapeutic alliance within the behaviour change process. This lack of direct support needs to be addressed within the DBCI design because poorly communicated strategies can themselves lead to non-adherence. If a user does not understand the DBCI content or strategy they are likely to disengage behaviourally and digitally.

4.1.5 Working Model Theory to Illustrate the Experience of Non-Adherence (WMTENA)

Johansson *et al.* (2015) conducted semi-structured interviews which identified several reasons why participants did not adhere to the 'Internet Cognitive Behavioural Therapy (ICBT)' programme. These were grouped into two categories: 'perception of treatment' and 'patient's situation' (see Figure 4.4). Each factor in the first category was linked with a corresponding factor in the second. For example, 'extensive content' (perception of treatment) was linked to various 'life factors' (patient's situation), including the inflexibility of the content when trying to fit it into a daily routine – such as the length

or level of difficulty. Equally 'demands of reading and writing' caused problems for less educated patients, overestimating their individual 'capability'.

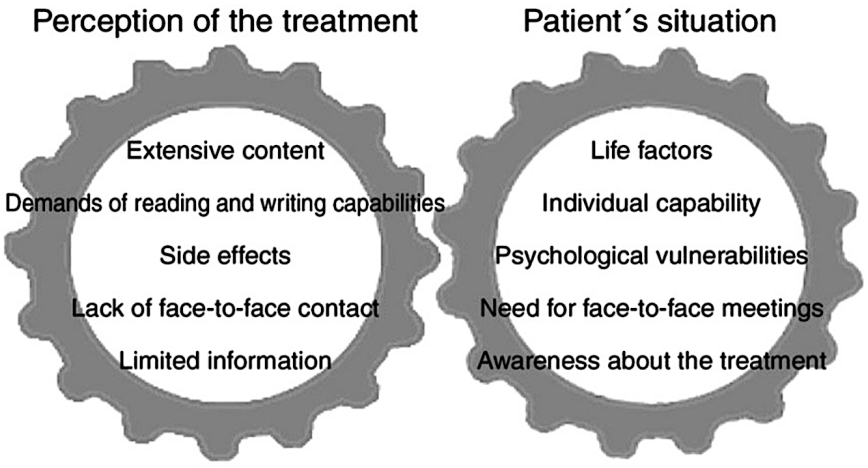

Figure 4.4: 'Working Model Theory to Illustrate the Experience of Non-Adherence' taken from Johansson *et al.* (2015, p.139)

This model was generated from interviews with seven patients – six female, one male – potentially limiting its generalisability. However, this model was included in the analysis because it is one of the only models to specifically collect qualitative data on disengagement – in the form of non-adherence. These factors are therefore specifically focused on behavioural disengagement and the factors affecting non-usage.

This model emphasises – similar to HBM – the importance of perception of treatment and the patient's situation. It also clearly depicts the interactions and dependencies between various factors. This provides further support for the importance of relationships between disengagement factors and the fact that researchers should be encouraged to explore these within their research.

4.1.6 Identified Factors

Table 4.1 presents a summary of the five models (and their related terms) that were explored in this section. Behaviour change interventions can aim to support a target behaviour or help adherence to specific treatments. For this reason, factors relating to the outcome of the intervention have been combined under the label 'behaviour/treatment' as these depend on the type of DBCI being researched.

Many of these models and publications use slightly different terms to define the same or similar concepts. Synthesising these factors into one table led to the identification of similar terms, which were grouped under an appropriate label in the 'Emergent Factors' column. If a publication used a different term to the one listed, the tick has been bracketed.

Table 4.1: Summary table of the five selected models illustrating the overlap between behavioural disengagement factors

Emergent Factors	**1.HBM**	**2.INT**	**3.IMS**	**4.PPTNA**	**5.WMTENA**
Ability		✓	✓	(✓)	(✓)
Age	✓	✓	✓	✓	
Behaviour/Treatment - Barriers (Perceived)	✓	(✓)	✓	(✓)	(✓)
Behaviour/Treatment - Benefits (Perceived)	✓	(✓)	✓	(✓)	
Behaviour/Treatment - Cues to Action	✓		✓		
Behaviour/Treatment - Effectiveness		(✓)	✓	(✓)	
Behaviour/Treatment - Environmental Constraints		✓	(✓)	(✓)	
Behaviour/Treatment - Intention		✓	✓		
Behaviour/Treatment - Motivation		(✓)	✓	(✓)	(✓)
Behaviour/Treatment - Past Experiences				✓	
Behaviour/Treatment - Perceptions		(✓)	(✓)	✓	(✓)
Behaviour/Treatment - Self-efficacy	✓	✓	✓		
Behaviour/Treatment - Side Effects					✓
Behaviour/Treatment - Strategy			✓	(✓)	(✓)
Behaviour/Treatment - Strategy (Collaborative Development)			(✓)	✓	
Demographics	(✓)	✓	(✓)	✓	
Emotions				(✓)	(✓)
Ethnicity	✓	(✓)	(✓)	✓	
Gender	✓	✓		✓	
Illness - Perceptions	(✓)	(✓)	✓	(✓)	
Intervention - Content			(✓)	(✓)	✓
Knowledge	✓		✓		(✓)

Continues on the next page ...

Emergent Factors	**1.HBM**	**2.INT**	**3.IMS**	**4.PPTNA**	**5.WMTENA**
Personality	✓	✓		(✓)	
Psychosocial			✓	(✓)	(✓)
Skills		✓			✓
Social Norms		✓	✓	✓	
Socio-economic	✓	✓	✓	✓	
Support - Family & Friends			✓	(✓)	
Support - Healthcare Professional			(✓)	(✓)	(✓)

These different terms, such as 'attitudes' and 'beliefs', can all be grouped under one factor: 'behaviour/treatment - perceptions'. This factor emphasises the role of the individual's reaction to and views about the suggested treatment or target behaviour. Asking an individual what they think about the treatment or target behaviour will generate data about their assumptions, beliefs and attitudes, covering these different aspects of their perception. For example, the 'Integrative Model' (INT) discusses the individual's 'attitudes towards targets'; the target referring to the target behaviour or treatment (Fishbein, 2000, p.274). The 'Information-Motivation-Strategy Model' (IMS) explains that an individual will only 'follow treatments they believe in' (DiMatteo *et al.*, 2012, p.81). The 'Predictors of Psychosocial Treatment Non-Adherence Model' (PPTNA) explains that 'perceptions, attitudes, and assumptions' about a treatment will affect adherence (Gearing *et al.*, 2014, p.37).

Similarly, the emergent factor 'support - healthcare professional' encompasses a number of interlinking model-specific terms. The models highlighted different aspects and variables relating to the patient-clinician relationship. The IMS Model explains that good communication was 'essential' between the patient and healthcare professional, to ensure that information was understood correctly (DiMatteo *et al.*, 2012, p.80). The PPTNA Model stated that the clinician's background, client's demographics, and their 'therapeutic alliance'[2] affects the patient's adherence (Gearing *et al.*, 2014, p.38). The 'Working Model Theory to Illustrate the Experience of Non-Adherence' (WMTENA) highlighted that participants felt their 'therapist did not really care' and this led to non-adherence (Johansson *et al.*, 2015, p.140). Exploring the level of support an individual feels from their healthcare professional will unpick many of these different model-specific variables. All these models look at the individual factors in order to understand the relationship between the individual and their healthcare professional and they are encapsulated by the 'support - healthcare professional' factor.

[2]Define as 'the quality of the bidirectional and interactional influence of client and clinician characteristics' (Gearing *et al.*, 2014, p.38)

These examples illustrate the kind of synthesis carried out on all the models which led to the categorisation of similar terms under 'Emergent Factors' in Table 4.1. To my knowledge there are no disengagement frameworks which explore health-related DBCIs. Therefore this section has explored models relating to behaviour change and theory, in order to identify behavioural factors. Factors that appear multiple times in Table 4.1 are therefore a good starting point to begin exploring this phenomenon from the perspective of behavioural disengagement. This table will be combined with the tables from the other literature sections to generate the disengagement framework.

4.1.7 Summary: Behavioural Intervention Models

The models in this section have identified a number of different factors which can lead to behavioural disengagement. The 'Health Belief Model' (HBM) (Rosenstock, 1974) and 'Integrative Model' (INT) (Fishbein, 2000) identify the factors relating to the performance of a health-related behaviour. These two models provide factors that lead to behavioural disengagement; why an individual does not carry out a health-related behaviour.

The other three models – 'Information-Motivation-Strategy (IMS) Model' (DiMatteo *et al.*, 2012), 'Predictors of Psychosocial Treatment Non-Adherence' (PPTNA) (Gearing *et al.*, 2014), and 'Working Model Theory to Illustrate the Experience of Non- Adherence' (WMTENA) (Johansson *et al.*, 2015) – specifically focus on the issue of adherence. Adherence – as defined in Chapter 3 – is the extent to which an individual or group of individuals use an intervention, in relation to the expected or intended use. These models therefore explore the factors specifically relating to the use of an intervention – rather than performing a particular behaviour – and therefore provide a different set of behavioural disengagement factors.

In addition to the identification of these factors, several key ideas have arisen from this critique of behavioural intervention models, including the importance of relationships between factors, perceptions and beliefs, and an individual's support network.

Interaction between factors was a consistent element in many of the models in this section. This emphasises the need for a framework of disengagement factors where interactions and relationships between components can be explored. This requires planning and the correct data collection for all relevant factors.

Another key component is an individual's perception and beliefs. An individual's perception impacts a number of other factors including the intervention content, the technology, and the healthcare professional or researcher. The individual's perception of the healthcare professional can also be influenced by the level of support they feel they are getting from the professional; a good communication channel between these individuals is vital. This ensures that concerns and potential barriers to DBCI usage can be addressed.

Following this, individuals also need a good support network – friends and family – who support the behaviour change attempt and the use of the DBCI. These themes need to be explored within disengagement research to fully understand the reasons for behavioural disengagement.

Finally this section presented a table of behavioural factors that were identified in the various models. This is the starting point for the disengagement framework, which will be built upon in the subsequent literature sections.

4.2 Digital Behavioural Intervention Models

The previous section investigated adherence models to better understand behavioural disengagement. Since the evolution of DBCI, there have been many models which attempt to guide the development of digital interventions. These models explore factors relating to behaviour change and various technological features or barriers which can provide insights for digital-behavioural disengagement.

These models were identified through a series of Google Scholar literature searches. Each search included the terms 'digital behaviour change' (or 'behavior change') AND 'health' AND 'model' (or 'framework') and was limited to the six year period between 2009 and 2015.

The first model – Ritterband *et al.*'s (2009) 'Internet Intervention Model' (IIM) – aims to support the development and critique of DBCIs, combining research from Psychology, Marketing, Web development, Behaviour Change, and clinical experience. It focuses on how to utilise the Internet for DBCIs. The model has some limitations regarding implementation, which possibly account for its lack of adoption in DBCI development (Hilgart *et al.*, 2012). However, the model components are widely cited and these provide insights into digital-behavioural disengagement.

The second two models – 'Theoretical Model of Motivational Technology to Promote Preventive Health Behaviours' (MTPHB) (Sundar *et al.*, 2012) and the 'Persuasive Systems Design Model' (PSDM) (Oinas-Kukkonen, 2013) – are from the field of persuasive technology. These models explore the persuasive nature of technology and how to utilise these features within the DBCI design.

Sundar *et al.*'s model (2012) is less well known than Oinas-Kukkonen (2013) but interestingly explores how the design of technology can relate to intrinsic motivation. Motivation is a significant issue within Behaviour Change research and therefore this is a vital area of research to understand. Oinas-Kukkonen's (2013) model is widely adopted and is one of the most renowned models within the persuasive technology research community (Kelders *et al.*, 2012). It should therefore provide a good overview of factors and barriers relating to persuasive health technology.

The 'Model of User Engagement in Online Interventions' (MUEOI) by Short *et al.* (2015) is particularly valuable because it combines the findings of a number of significant models, including Ritterband *et al.*'s (2009), Oinas-Kukkonen's (2013), as well as various User Engagement (UE) models to specifically explore engagement with DBCIs.

This is not an exhaustive list of digital behavioural intervention models for DBCIs. However, it covers a range of research within this field to provide a maximum variation sample. This research will provide an insight into the digital-behavioural disengagement factors from a Behaviour Change perspective. It will build upon the adherence models described in the previous section and will be further developed by the HCI research (in Chapter 5) to present a holistic range of digital-behavioural disengagement factors.

4.2.1 Internet Intervention Model (IIM)

Ritterband *et al.* (2009) proposed a model to help develop and critique DBCIs (see Figure 4.5). This model was designed to provide the theoretical basis to explain both how Internet Interventions (II) can change behaviour, and provide a theoretically grounded method of developing and testing these interventions (Ritterband *et al.*, 2009).

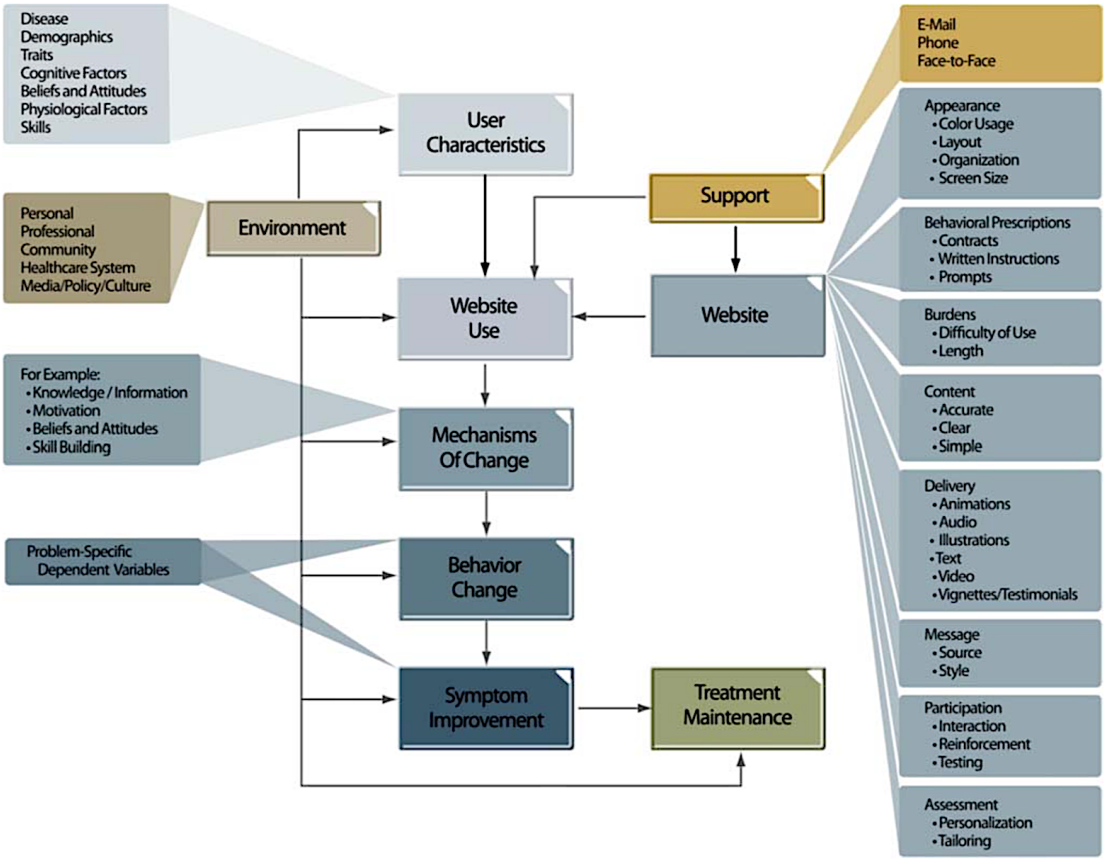

Figure 4.5: 'Internet Intervention Model' taken from Ritterband *et al.* (2009, p.20)

The model consists of nine components and was constructed from numerous disciplines and theories, including Psychology, Marketing, Web development, Behaviour Change, and clinical experience (Ritterband *et al.*, 2009, p.19). Each of these components can be broken down further into variables that need to be considered during intervention design. For example, 'user characteristics' includes factors such as 'disease', 'demographics', 'traits', 'cognitive factors' etc. Some of these variables are fixed, such as 'age', whilst others can change over time, such as 'beliefs and attitudes' about the treatment and their ability to change.

Ritterband *et al.* (2009, p.24) stipulate that a model is only useful if it can be evaluated, critiqued and developed. For this reason, they propose a 'measurement' overlay which should be applied to all components, sub-components and sections of the model. They provide examples of how the interactions between components should be investigated, for example to what 'extent' a user's characteristics affects their website use.

This model proposes various important considerations for the development of a DBCI, including the impact of the individual's personal environment or usage context, aspects of the website (message source and length burden), and user traits. It identifies the aspects of a DBCI that promote behaviour change and usage. The identified components therefore highlight potential factors which could discourage usage, providing a starting point for digital-behavioural disengagement factors.

This research touches upon a wide range of components for DBCI development and analysis. However, Ritterband *et al.* (2009) acknowledge that the model is an over-simplification of the development process and therefore could lack some of the aspects required to explain behaviour change in full. This limits its usefulness and potentially suggests that it needs to be used in conjunction with other models or theories. This oversimplification also applies to a number of the model's other components. It provides various examples of features – such as animation or use of colour – but does not state how to best use these within the design. Additionally, Ritterband *et al.* (2009) identify the need for measurable components but it is not clear how these could be identified, nor what procedures should be used. Future models, especially regarding disengagement research, should propose processes for the collection and analysis of data.

Furthermore, the 'support' component of the model includes 'email', 'phone', and 'face-to-face' contact with a clinician. However, this type of support can reduce the advantages of the digital format, such as wide-spread delivery and reduced costs. Other models have explored alternative ways to offer support – such as the individual's social network (Gearing *et al.*, 2014) – which utilises the benefits of the digital format.

The oversimplification of this model may have limited its use within DBCI analysis, which partly explains its lack of adoption (Hilgart *et al.*, 2012). However, the factors nonetheless provide a good starting point for digital-behavioural disengagement.

4.2.2 Theoretical Model of Motivational Technology to Promote Preventive Health Behaviours (MTPHB)

Sundar *et al.*'s (2012) model hypothesises that increasing intrinsic motivation will promote engagement with health content, leading to better attitudes towards and adoption of health behaviours (see Figure 4.6). The model focuses on three aspects of design: 'navigability', 'interactivity', and 'customisation'.

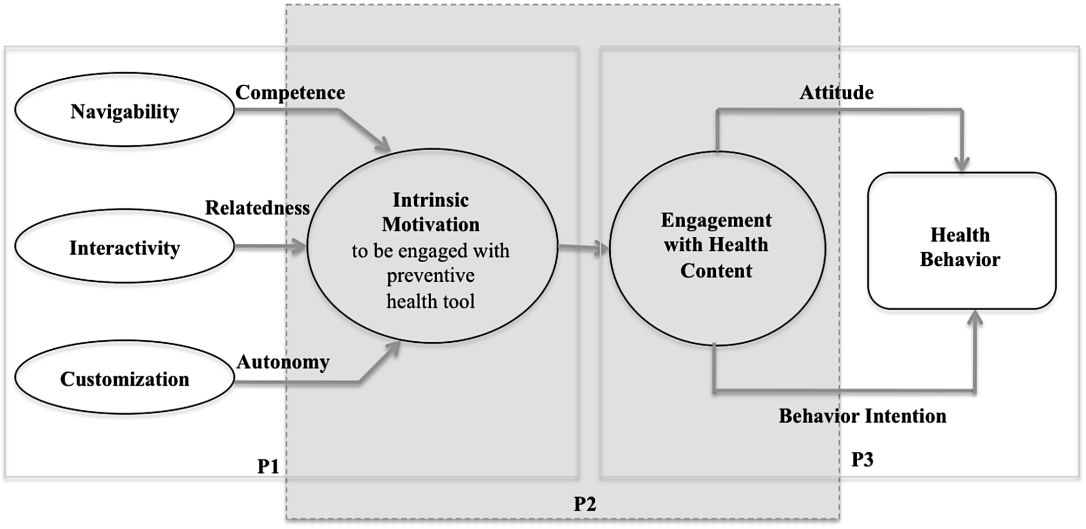

Figure 4.6: 'Theoretical Model of Motivational Technology to Promote Preventive Health Behaviours' taken from (Sundar *et al.*, 2012, p.116)

The model directly links 'navigation' with the user's feelings of 'competence'; a user will feel more confident in their ability to achieve their usage goals, if they find the system easy to navigate (Sundar *et al.*, 2012, p.115-117). Tools such as search bar, sitemaps, and drop-down menus can provide visual cues that help guide navigation. Sundar *et al.* (2012, p.117) link the 'interactivity' of the site with a user's feelings of 'relatedness'. Interacting with other users through the system promotes a user's sense of community and can provide social or emotional support (Sundar *et al.*, 2012, p.117). Sharing content can also encourage a sense of community amongst users. Finally, this model suggests that 'customisation' can promote a user's sense of 'autonomy' and personal agency. An increase in personal agency means the user is likely to feel more involvement with the system, a higher level of control, and a stronger sense of identity with their online interactions (Sundar *et al.*, 2012, p.117-118).

This model provides useful insight into the factors relating to motivation and how elements of the DBCI design can address these. This relationship between intervention design and aspects of intrinsic motivation are also supported by other pieces of research (for example Yardley *et al.* (2015)).

There are a number of limitations to this model, primarily that it is theoretical and therefore the combination of these factors has not been tested. Furthermore, there is conflicting research about the impact of customisation on users. Sundar & Marathe (2010) found that different types of users preferred different types of tailoring. The 'power users' – technology adopters who are confident and push technology to its limit – preferred user-initiated customisation (Sundar & Marathe, 2010, p.300). On the other hand, 'non-power users' – individuals that lack expertise and the desire to adopt new technology – preferred system-initiated personalisation (Sundar & Marathe, 2010, p.300). Therefore although customisation may increase a sense of autonomy, it may not appeal to all users and may even demotivate or digitally disengage some users. Understanding this relationship is important because tailoring – of any kind – can be time-consuming for the developer.

This model may also oversimplify the relationship between engaging with health content and performing a health behaviour. It suggests that it simply requires certain attitudes and behavioural intention. However, many models suggest additional factors such as behavioural triggers or environmental barriers.

On the whole this model does provide some helpful design suggestions to promote intrinsic motivation, and motivation is a big part of the behaviour change process. Good navigation, tailored content, and social interactivity do appear to have a positive impact on a user's motivation and these will certainly need to be considered in a DBCI design. However, such considerations raise further questions that need to be addressed. For example, *good* navigation might mean different things for different users. Therefore, understanding how the specific target population are perceiving these elements of DBCI design will provide insight into digital disengagement.

4.2.3 Persuasive Systems Design Model (PSDM)

'Behaviour Change Support Systems' (BCSSs) are socio-technical systems that persuade users to alter attitudes or behaviours, without the use of coercion or deception, to encourage behaviour change (Oinas-Kukkonen, 2013, p.1225). BCSSs are not *specifically* focused on health-based behaviour change but they have been widely used within the persuasive design context (Kelders *et al.*, 2016).

The 'Persuasive Systems Design Model' (PSDM) – which builds upon the early work of Oinas-Kukkonen & Harjumaa (2009) – proposes three stages for BCSS development: 'persuasion postulates', 'persuasion context', and 'persuasive software features' (see Figure 4.7).

Before starting the development of a BCSS, it is important to consider the seven persuasion 'postulates' or 'assumptions' (see Table 4.2). Once these have been considered the designer can move on to the 'persuasion context' phase. The 'persuasion context'

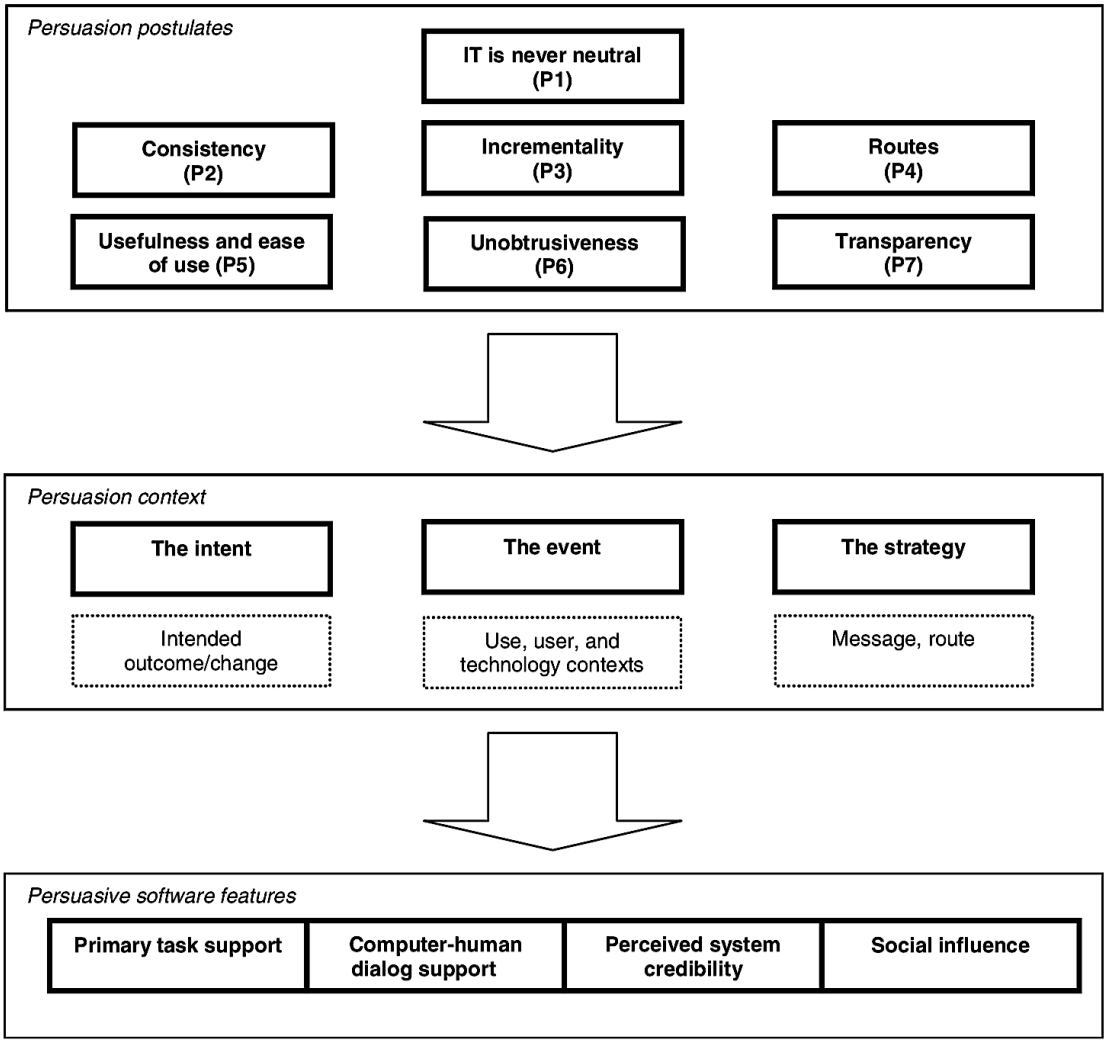

Figure 4.7: 'Persuasive Systems Design Model (PSDM)' taken from Oinas-Kukkonen (2013, p.1228)

encourages a designer to consider three aspects of usage: 'the intent' (behaviour outcome or change), 'the event' (the technological use and context), and 'the strategy' (the intervention message or route) (Oinas-Kukkonen, 2013, p.489). This separation of 'event' and 'strategy' is in line with the separation of disengagement research into digital and behavioural considerations.

The 'persuasive software features' are separated into four strategies: 'primary task support', 'computer-human dialog support', 'perceived system credibility', and 'social influence' (Oinas-Kukkonen, 2013, p.1228). These components propose different ways in which the system can persuade or motivate the user.

The 'primary task support' addresses aspects of the design which aim to support the user's primary goal (Oinas-Kukkonen, 2013, p.1228). Strategies include 'reduction', 'tunnelling', 'tailoring', 'personalisation', 'self-monitoring', 'simulation', and 'rehearsal' (Oinas-Kukkonen & Harjumaa, 2009, p.492) (see Appendix A Table A.1 for definitions).

Table 4.2: 'Seven Persuasion Assumptions' adapted from Oinas-Kukkonen (2013, p.1227-1228)

Issues	**Explanations**
IT is never neutral	Never neutral; rather, it always has an impact on the user.
Consistency	People like their views about the world to be organized and consistent.
Incrementality	Persuasion is often incremental.
Routes	The direct and indirect routes are key persuasion strategies.
Usefulness and Ease of Use	Behaviour change support systems should be both useful and easy to use.
Unobtrusiveness	Persuasion through behavior change support systems must always be unobtrusive to a user's primary tasks.
Transparency	Persuasion through behavior change support systems should always be transparent.

These design suggestions try to increase persuasive power by making the system content and structure as relevant to the user and the specific target behaviour as possible.

The 'computer-human dialog support' – or 'dialogue support' – addresses the need for system feedback including 'praise', 'rewards', 'reminders', 'suggestion', 'similarity', 'liking', and 'social role' (Oinas-Kukkonen & Harjumaa, 2009, p.493) (see Appendix A Table A.2 for definitions).

The 'perceived system credibility' refers to the design choices that can promote a user's trust in the system, increasing the likelihood of persuasion (Oinas-Kukkonen, 2013, p.1228). There are a number of strategies to promote trust in a system, including 'trustworthiness', 'expertise', 'surface credibility', 'real-world feel', 'authority', 'third-party endorsements', and 'verifiability' (Oinas-Kukkonen & Harjumaa, 2009, p.494) (see Appendix A Table A.3 for definitions).

Finally, 'social influence' – or 'social support' – utilises the influence that other people can have on a user. There are a number of ways to influence these social aspects: 'social learning', 'social comparison', 'normative influence', 'social facilitation', 'co-operation', 'competition', and 'recognition' (Oinas-Kukkonen & Harjumaa, 2009, p.495) (see Appendix A Table A.4 for definitions).

Both the 'primary task support' and the 'computer-human dialog support' focus specifically on aspects of the technology or DBCI – the design of the intervention – using methods such as content tailoring, tunnelling a particular route through the system, and virtual rewards or reminders. The latter two aspects, 'perceived system credibility' and 'social influence', focus specifically on the user. The first addresses the idea of user perception: i.e., how credible the user will find the DBCI, and whether the messages

received carry authority. The second considers the user within their wider social network: i.e., how to utilise this network to motivate or challenge the user. These provide interesting factors for the disengagement framework.

PSDM highlights the importance of credibility or trust for persuasion. DiMatteo *et al.* (2012, p.81) also found that individuals need to believe in the treatment plan if they are to follow it. Trust is therefore likely to be an important aspect of DBCI usage, ensuring the intervention's persuasive ability and effectiveness. Without trust, users are likely to disengage digitally and behaviourally, and therefore the issue of trust should certainly be explored within disengagement research.

But the model also has its limitations for DBCI development: for example, lack of detail, appropriateness of certain software features, and the selection of design strategies.

Firstly, elements of the model lack actionable details. For example, 'the event' consists of the 'use, user, and technology contexts' but there is no additional information explaining how these should be accounted for within the system design. Oinas-Kukkonen (2013, p.1231) also mentions the flaw of grouping users as a homogeneous mass but does not expand upon the idea of user segmentation or user profiles. The 'technology context' and 'purpose' may also require additional design considerations such as mobile use or the therapeutic alliance, but these are not explained.

Secondly, certain 'persuasive software features' may not be appropriate within a health setting. For example, extrinsic 'rewards' or 'praise' can undermine a user's intrinsic motivation (Deci & Ryan, 2008, p.15). Externalising a user's motives can reduce the chance of long-term behaviour change because if they stop using the DBCI, they will no longer benefit from the extrinsic motivation of the virtual reward. Sardi *et al.* (2017) did find that extrinsic rewards lead to short-term engagement, suggesting elements such as gamification, which need to be considered for their impact on extrinsic and intrinsic motivation. Sardi *et al.* (2017, p.41) also found that certain game elements motivated some users whilst demotivating others, thereby causing diverse reactions amongst users, leading some to disengage.

Finally, the four components of 'persuasive software features' are explored in great depth by Oinas-Kukkonen & Harjumaa (2009), presenting a number of actionable design strategies. The list is fairly comprehensive but it would be too demanding for a DBCI designer to implement all of these strategies and some may be more appropriate than others. Disengagement research can offer invaluable insight by identifying the elements of design that lead to non-usage, allowing developers to focus their efforts on those particular aspects of design.

This model, like many others mentioned in this chapter, is not designed for disengagement research. However, it was built within the persuasive design field and engagement is a consideration within this context because a user must be '*pay[ing] attention* to the

arguments presented' (Oinas-Kukkonen & Harjumaa, 2009, p.489). As a result, the model signposts a number of significant areas of design, which should be considered in disengagement research. Particular areas of note include: the user, the user's environment, functionality of the intervention, credibility and delivery of message content, the need for a defined intervention intention, and the situation of use. Furthermore, Oinas-Kukkonen's research (2013, p.1231) research states that users should not be thought of as a homogeneous group and therefore design elements which work for one user may not work for another. Disengagement research can provide further evidence and insight into demotivating factors.

4.2.4 Model of User Engagement in Online Interventions (MUEOI)

Short *et al.* (2015) present the 'Model of User Engagement in Online Interventions' (MUEOI), which builds upon several existing models: the 'Elaboration Likelihood Model' (ELM), O'Brien & Toms' (2008) 'Model of Engagement' (MoE) (see Section 5.2.1), Ritterband *et al.*'s (2009) 'Internet Intervention Model' (IIM) (see Section 4.2.1), and Kelders *et al.*'s (2012) usage of Oinas-Kukkonen & Harjumaa's (2009) 'Persuasive Systems Design Model' (PSDM).

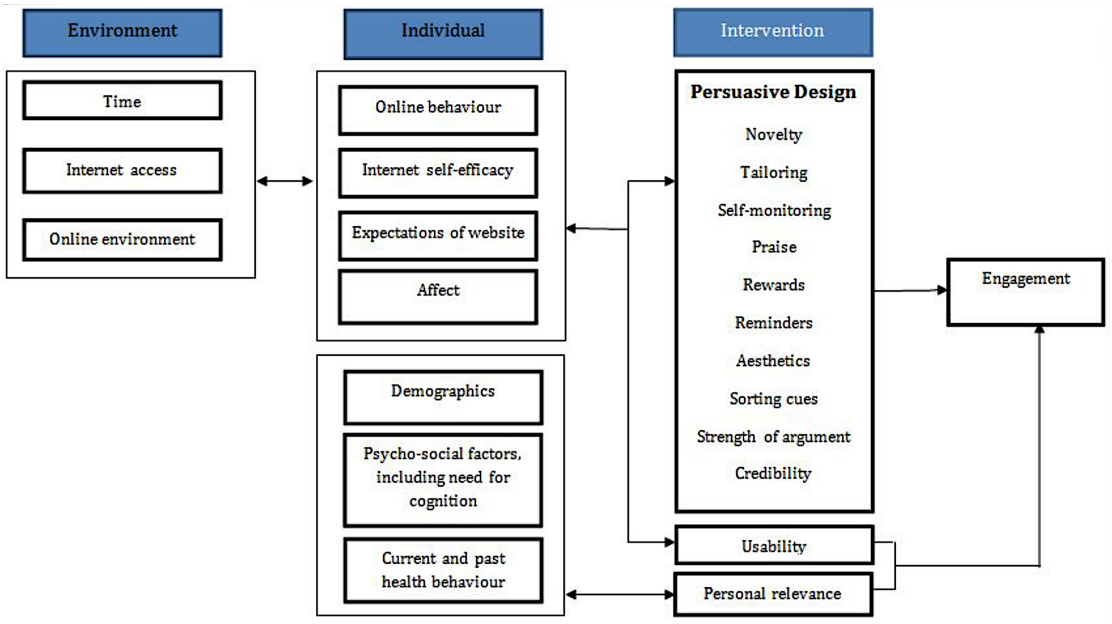

Figure 4.8: 'Model of User Engagement in Online Interventions' (MUEOI) taken from Short *et al.* (2015, p.34)

The model proposes three main considerations for engagement with online interventions: the 'environment', the 'individual', and the 'intervention' (see Figure 4.8). The 'environment' relates to external influences on the user and their intervention usage. For example, the user's 'internet access' and expectation of the intervention – based on

comparative online services – will influence engagement and the DBCI's persuasive ability. Short *et al.* (2015, p.35) hypothesise that the relationships between the engagement determinants are bidirectional, incorporating both feedback and experiences.

This model specifically focuses on a user's engagement with a DBCI rather than usage. Short *et al.* (2015, p.35) claim that the model is supported by other psychosocial and ecological models and therefore the identified factors are likely to provide useful insight into digital disengagement. In addition, Short *et al.* (2015, p.35) state that a user is most likely to engage when the intervention is personally relevant, novel, and aesthetically pleasing.

Short *et al.* (2015) – like Ritterband *et al.* (2009) – state the limitations of their model by explaining that it may be an 'oversimplification' of engagement with DBCI. However, they claim that it does provide a foundation on which to test and map design-assumptions. The model is not complete and Short *et al.* (2015, p.35) encourage researchers to use it alongside health behaviour change models for a comprehensive approach to DBCI development. This limits its usefulness as it is difficult to know how to use such a model to promote engagement when there are potentially missing determinants.

The 'Model of User Engagement in Online Interventions' (MUEOI) identifies several key constructs which might relate to engagement, including personal relevance, novelty, and aesthetics. It also emphasises the impact and connection between the environment, individual, and the intervention. This is a good starting point for behavioural and digital disengagement research and a good synthesis of several leading models.

4.2.5 Identified Factors

Table 4.3 summarises the factors identified from the models presented in this section. Some of these models aim to support the performance of a desired behaviour whilst others refer to certain treatments. For the purposes of this table, factors relating to these two types of interventions have been combined under a linked category 'behaviour/treatment'. This is because these factors all refer to the intended outcome of the intervention. Furthermore, some DBCIs may attempt both to alter behaviour and also to support certain medical treatments.

Many of these models and publications use slightly different terms to define the same or similar concepts. Synthesising these factors into one table led to the identification of similar terms, which could subsequently be listed under one 'emergent factor'. If a publication used a different term to the one listed, the tick has been surrounded by brackets; for example see 'intervention - tailoring'.

These models refer to a range of tailoring methods. In the health-based DBCI context 'tailoring' is defined as the adaptation of information or advice based on a user's characteristics and behaviours (Morrison, 2015, p.2). There are two main ways of tailoring: system-initiated (personalisation) and user-controlled (customisation) (Orji *et al.*, 2017, p.413). The 'Internet Intervention Model' (IIM) explained the importance of 'personalization and tailoring' for DBCIs (Ritterband *et al.*, 2009, p.22), whereas the 'Theoretical Model of Motivational Technology to Promote Preventive Health Behaviours' (MTPHB) discusses customisation to increase feelings of autonomy (Sundar *et al.*, 2012, p.116). Short *et al.* (2015, p.33) also discuss 'computer-tailoring' to increase the 'personal relevance' of messages. The 'Persuasive Systems Design Model' (PSDM) includes the concept of tailoring to increase the persuasiveness of the information and message (Oinas-Kukkonen & Harjumaa, 2009, p.1228). These different types of tailoring can impact a number of different aspects of the DBCI. For example, Sundar *et al.* (2012, p.116) found that customisation 'boost[ed] user agency and self-determination'. However, Sundar & Marathe (2010) also found that different types of users preferred different types of tailoring. Using the term 'tailoring' rather than one of the more specific methods ensures that disengagement researchers explore the user's reaction to all types of adaptation. Researching 'Intervention - tailoring' will lead to a better understanding of the impact that these types of features have on behavioural and digital disengagement.

Similarly all four models referred to some form of notification or reminder: 'intervention - notifications'. However, not all the models referred to this in the same way. For example, IIM discussed the benefit of using 'prompts' such as 'automated emails' or 'phone calls triggered by the program' (Ritterband *et al.*, 2009, p.21). On the other hand, MTPHB suggested the use of 'interface cues' as a way of highlighting the 'social support' users were receiving through the DBCI (Sundar *et al.*, 2012, p.119). PSDM includes the concept of 'computer-human dialog', such as 'timely suggestions' and 'real-time reminders' (Oinas-Kukkonen, 2013, p.1228). Short *et al.* (2015) also incorporated 'reminders' into their 'Model of User Engagement in Online Interventions' (MUEOI). These models use a range of terms – prompts, reminders, and cues – but they all relate to making the user aware of the system, a specific piece of information, or a change in the system, i.e. a notification. This factor, 'intervention - notifications', therefore encourages researchers to consider all interactions between the user and the DBCI and what impact these are having on their experience and usage.

These two examples – 'intervention - tailoring' and 'intervention - notifications' – illustrate the process conducted across the various models and their related terms. The previous table is the outcome of this synthesis. To my knowledge there are no disengagement frameworks which explore health-related DBCIs. Therefore this section has identified a number of factors relating to behaviour change and the various technological features or barriers which users might face.

There are a number of factors that appear in both behaviour change tables (Table 4.1 and Table 4.3) – such as 'ability', 'demographics', 'perceptions', and 'motivation'. This implies that they are of particular interest when exploring behavioural disengagement. However, in order to fully understand disengagement, a researcher must also explore digital factors for disengagement. These two tables will therefore be combined with the HCI literature to create the disengagement framework.

Table 4.3: Summary table of the four selected models illustrating the overlap between behavioural and digital disengagement factors

Emergent Factors	**1.IIM**	**2.MTPHB**	**3.PSDM**	**4.MUEOI**
Ability	(✓)		✓	✓
Age	✓		(✓)	
Behaviour/Treatment - Barriers (Perceived)	✓			
Behaviour/Treatment - Benefits (Perceived)	✓			
Behaviour/Treatment - Effectiveness	(✓)		(✓)	
Behaviour/Treatment - Intention	✓	✓	✓	
Behaviour/Treatment - Motivation	✓	✓	✓	(✓)
Behaviour/Treatment - Past Experiences			✓	✓
Behaviour/Treatment - Perceptions	(✓)	✓	(✓)	(✓)
Behaviour/Treatment - Self-efficacy	✓	✓	✓	
Behaviour/Treatment - Side Effects	(✓)		(✓)	
Behaviour/Treatment - Strategy	(✓)	(✓)	(✓)	(✓)
Competing Apps & Websites				(✓)
Demographics	✓		(✓)	✓
Emotions		(✓)	(✓)	(✓)
Gender	✓		(✓)	
Illness - Perceptions	(✓)			
Intervention - Aesthetics	(✓)	(✓)	(✓)	✓
Intervention - Content	✓	(✓)	(✓)	(✓)
Intervention - Content Delivery	✓		(✓)	✓
Intervention - Credibility	✓		✓	✓
Intervention - Expectations	✓		(✓)	✓
Intervention - Feedback	✓	✓	✓	✓
Intervention - Interactivity	✓	✓	(✓)	(✓)
Intervention - Navigation	✓	✓	(✓)	
Intervention - Notifications	(✓)	(✓)	(✓)	(✓)

Continues on the next page ...

Emergent Factors	**1.IIM**	**2.MTPHB**	**3.PSDM**	**4.MUEOI**
Intervention - Social Network		✓	✓	
Intervention - Tailoring	✓	(✓)	✓	✓
Intervention - Usability	(✓)	(✓)	(✓)	✓
Intervention - Usefulness			✓	
Knowledge	✓		✓	
Personality	✓		✓	
Psychosocial	(✓)		(✓)	✓
Self-efficacy - Technical		✓		(✓)
Skills	✓	(✓)	✓	(✓)
Skills - Technical	✓	(✓)		(✓)
Social Norms			✓	
Socio-economic	✓			
Stage of Change	✓			
Support - Family & Friends	✓			
Support - Healthcare Professional	✓		(✓)	(✓)
Support - Intervention Design		(✓)	(✓)	
Support - Other Users		✓	(✓)	
Usage - Barriers	✓			✓
Usage - Context	(✓)		✓	(✓)
Usage - Experience	(✓)	(✓)	✓	(✓)
Usage - Intention	✓	✓		
Usage - Internet Access	✓			✓
Usage - Motivation		(✓)		✓
Usage - Time				✓

4.2.6 Summary: Digital Behavioural Intervention Models

This section has explored models that focus on the behaviour change components and digital considerations of DBCI design, leading to the development of Table 4.3. Many of these models propose a number of key influencers determining the success of a DBCI – the individual, functionality of the intervention, credibility, and situation of use.

Each model has a slightly different approach to modelling the development or usage of a DBCI. Ritterband *et al.*'s (2009) 'Internet Intervention Model' (IIM) offers an overview of components which need to be considered within DBCI development and analysis. However, Ritterband *et al.* (2009) recognise that it may be an 'oversimplified' version of the process and some of the components require further explanation before they can be incorporated into the design process. They emphasise the need for measurable components in an intervention model but it is not always clear how to implement these using their model.

Sundar *et al.*'s (2012) proposes a fairly simple relationship between DBCI design and aspects of intrinsic motivation. However, Sundar & Marathe (2010) found that customisation or personalisation may not appeal to all user types and could itself lead to some users disengaging. In addition, this model does not provide much insight into the gap between motivation and DBCI usage.

Oinas-Kukkonen (2013) proposes a number of strategies to create persuasive technologies. However, these strategies are fairly time-consuming to implement and therefore further research is required to identify which are the most effective within a DBCI behaviour-specific context.

Short *et al.* (2015) also acknowledge that their model may be an oversimplification of the engagement process. For this reason, it would be challenging to use this model to design an *engaging* DBCI. However, it identifies three key areas that should be explored within disengagement research: usage environment, the individual, and aspects of the intervention.

All four models present interesting components and considerations for design and disengagement. However, they all have areas of weakness, which make them challenging to use within a design process. They are good starting points but a focus on disengagement could help to identify problems with DBCI designs or identify how to best allocate resources during development. Furthermore, the limitations of several models highlights the need for a framework that can easily be used within DBCI development and analysis. Table 4.3 presented the synthesis of this literature review and identified additional factors for the disengagement framework.

4.3 Discussion and Summary: Behaviour Change Factors

This maximum variation review of Behaviour Change literature has highlighted multiple factors for consideration with DBCI disengagement. Section 4.1 focused on adherence (and health beliefs) to identify behavioural factors of disengagement (see Table 4.1). These factors were centred strongly around the individual, their perceptions, and their support network.

Section 4.2 explored a number of digital behaviour change intervention and persuasive design models. These were constructed from various research projects and well-established theories and models. This section identified a number of technological factors linked to the digital and behavioural aspects of disengagement. The generated list of factors (see Table 4.3) confirmed and extended many of the identified factors from Section 4.1.

Exploring the two tables together (see Appendix A Table A.5) shows that many of the factors are mentioned in both sections of research, such as 'demographics' and 'support'.

The models described in Section 4.1 provide a focus on the behavioural aspects, whereas those in Section 4.2 provide more of a digital focus, building upon and extending the behavioural models. This ensures that both sides of digital-behavioural disengagement are explored.

Comparing different models across the various research areas also emphasises the need for a clear usage of terms. Originally, Table 4.3 contained a single factor: 'barriers'. This was adequate when referring to the behaviour change literature. However, confusion arose when incorporating digital models and the barriers of digital usage. For this reason the tables now differentiate between 'barriers' relating to desired behaviour ('behaviour/treatment - barriers') and those relating to intervention usage ('usage - barriers'). This is true for a number of the different factors, such as 'intention' and 'motivation'.

Many of the researchers – such as Ritterband *et al.* (2009) or Short *et al.* (2015) – identified that their models potentially oversimplified the process of development, usage, or engagement with a DBCI. This is a problem when a model is meant to guide DBCI development. However, disengagement research is different. By identifying the higher-level factors – such as barriers to treatment or context of usage – researchers can focus their data collection on understanding the specific disengagement factors within a behaviour change context, guided by the more specific factors in the framework.

This is not an exhaustive review of behaviour change models and theories because the field is too extensive and constantly expanding. However, the focus on the different aspects of disengagement and the inclusion of hybrid models – generated from a number of existing models – provides a good sample of Behaviour Change literature for maximum variation.

All these models emphasise the fact that behaviour change attempts, including DBCI, are influenced by numerous factors, including the user, their environment, the intervention, and their support network. Each model has provided some factors for consideration in a disengagement framework and highlighted the need for a disengagement focused research agenda. Attempting to create a general model for designing a DBCI is inevitably complex because the context and specific health-condition are important factors for the design. However, a disengagement framework can evaluate a design that is being used by the intended user within the desired context.

This review provides insights from health-related Behaviour Change research. However, none of these models focus on the real-time experience of using a DBCI. This type of research is being conducted in the Human-Computer Interaction (HCI) field which is explored in the next chapter.

Chapter 5

Human-Computer Interaction Models and Disengagement

Chapter 4 reviewed Behaviour Change literature – focusing on behavioural models, adherence and digital intervention models – to identify behavioural and digital factors of disengagement. However, these various research models did not explore disengagement from a Human-Computer Interaction (HCI) perspective, factors that either affect adoption of technology or the experience of usage.

This chapter therefore examines models from an HCI perspective – including research from technology acceptance (and adoption), User Engagement (UE) and User Experience (UX) – to better understand digital disengagement from technology. These areas of research explore the interaction between a user and technology but focus on different stages or aspects of this phenomenon. Researching these different aspects provides a maximum variation sample (see Chapter 4) to provide the best scope for identifying disengagement factors. This will aid the development of an effective disengagement framework (RA2).

Technology acceptance models identify early barriers to adoption. For example, they consider why an individual will choose one technology over another. This is an important consideration for DBCI researchers as there are an increasing number of health apps and websites – varying in quality and effectiveness – that a user can choose from. These models can provide insight into early digital disengagement.

UE and UX are very similar constructs, which were explored in greater depth in Chapter 3. That analysis discovered the close relationship between these terms and the need to explore both phenomena in order to better understand interactions with technology. UE models help to explain the phenomenon of *engagement*, which is often cited as a quality of UX. The UX models focus on the various points in the interaction – including before, during, and after use – and how these impact long-term use and disengagement.

At the end of each section, there will be a table of identified factors, which have been generated from the discussed models. These tables will be used to create the disengagement framework (RA2) which is presented in Chapter 6.

5.1 Technology Acceptance and Adoption Models

This section explores user acceptance and adoption models, which can provide insight into the factors that affect early digital disengagement. The models explored within this section are widely cited. A few are extensions of well-known existing models which have particular perspectives to offer (for maximum variance), such as mobile technology or voluntary usage.

These models were identified through a series of Google Scholar searches which included the terms 'user adoption' (or 'user acceptance') AND 'model' AND 'technology'. The original search was limited to a six year period between 2010 and 2016. Models were excluded if they focused specifically on one domain – such as e-learning, social media, or MOOCS – rather than technology as a whole. This search identified a number of models that built upon earlier models, such as 'Technology Acceptance Model for Mobile Services' (TAMM) (Kaasinen *et al.*, 2011) and 'Extending the Unified Theory of Acceptance and Use of Technology' (UTAUT2) (Venkatesh *et al.*, 2012). The search was expanded to include these earlier models to ensure that all terms were defined and accurately represented. Furthermore, many of these earlier models are still regularly cited and still relevant.

The 'Technology Acceptance Model' (TAM) is one of the most widely cited models of adoption, according to Venkatesh & Bala (2008, p.274). It was also originally developed from a well-established behavioural theory – the 'Theory of Reasoned Action' (TRA) (Fishbein & Ajzen, 1975) – and explains why a user chooses to adopt a particular technology. This model has evolved over the years to include new constructs, leading to the development of TAM3 (Venkatesh & Bala, 2008). DBCIs need to be accepted by users and these models can provide insight into adoption or factors that lead to early disengagement.

The 'Technology Acceptance Model for Mobile Services' (TAMM) extends TAM by specifically focusing on factors relating to mobile apps (Kaasinen *et al.*, 2011). Many DBCIs are presented in an app form and therefore it is important to consider factors which may specifically relate to mobile technology.

The 'Unified Theory of Acceptance and Use of Technology' (UTAUT) was developed from eight different models and theories of usage and is widely cited and used within HCI (Venkatesh *et al.*, 2003). The 'Unified Theory of Acceptance and Use of Technology 2' (UTAUT2) builds upon UTAUT but considers the effect of context by exploring the

consumer rather than *organisational* setting. The consumer setting is considered to be voluntary and therefore this aligns more with a DBCI context. These models provide additional insights into disengagement factors.

These models provide factors that lead to early digital disengagement. Many of these factors may not be limited to this stage of DBCI interaction and therefore may also appear in the UE or UX models.

5.1.1 The Technology Acceptance Models (TAM, TAM2, TAM2b, TAM3)

In 2008, Venkatesh & Bala produced the 'Technology Acceptance Model 3' (TAM3), which evolved from the original 'Technology Acceptance Model' (TAM) (Davis *et al.*, 1989), 'The Extension of the Technology Acceptance Model' (TAM2) (Venkatesh & Davis, 2000), 'The Determinants of Perceived Ease of Use' – which will be referred to as (TAM2b) – (Venkatesh, 2000), as well as three additional constructs.

TAM3 contains 17 different elements which have been incrementally included over the various TAM iterations. To explore these, the following sections will provide an overview of each model but will limit explanations to the newly added factors and how these impact disengagement from a DBCI.

5.1.1.1 The Technology Acceptance Model (TAM)

The 'Technology Acceptance Model' (TAM) proposed a number of central constructs: 'perceived usefulness', 'perceived ease of use', and 'behavioural intention to use' (see Figure 5.1).

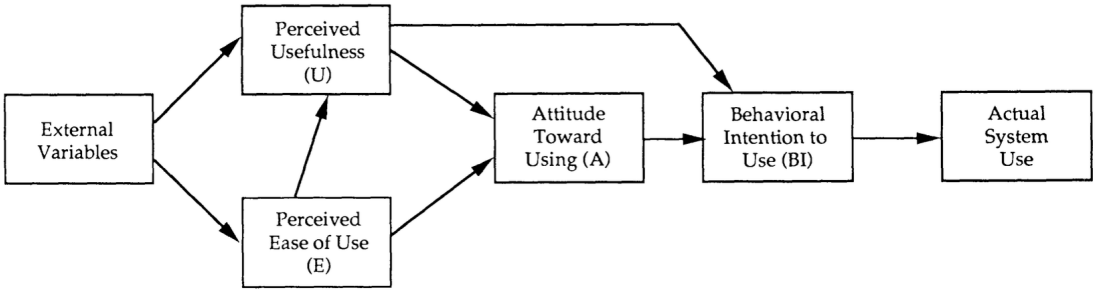

Figure 5.1: 'Technology Acceptance Model (TAM)' taken from Davis *et al.* (1989, p.985)

TAM evolved from the 'Theory of Reasoned Action' (TRA) (Fishbein & Ajzen, 1975) and therefore originally included an 'attitude toward using' component, which in turn fed into a user's behavioural intent (Davis *et al.*, 1989). However, 'attitude' appeared to have little impact on the relationship between perceptions and intentions, and was

removed from future model iterations. 'Perceived usefulness' and 'perceived ease of use' refer to the likelihood that the technology will improve job output and the expectation that the system will be effort free (Davis *et al.*, 1989).

This model explains the constructs that feed into an intention to use a piece of technology. Within a DBCI context, 'perceived usefulness' will be influenced by how helpful the individual finds the intervention in supporting their behaviour change attempt, in terms of content and features. If a user is not feeling supported by the DBCI, they may digitally disengage, which could also lead in turn to behavioural disengagement.

'Perceived ease of use' will relate more closely to the DBCI technology rather than its content or strategy. In particular, it will include the ease of navigation and other usability criteria. However, it will also be influenced by certain qualities of the content, such as the length of the text or the complexity of the language. For example, if a session is too long, an individual may find it difficult to find time to schedule it in.

TAM does not state the specific attributes of either 'perceived usefulness' or 'perceived ease of use'. However, TAM clearly states that a user's perception of the system is important. If the intervention does not align with these perceptions, the 'behavioural intention' will be affected and users may disengage from the DBCI.

5.1.1.2 The Extension of TAM (TAM2)

'The Extension of the Technology Acceptance Model' (TAM2) explains the variables that influence 'perceived usefulness' (Venkatesh & Davis, 2000, p.188) (see Figure 5.2). These factors are grouped into two processes: the 'social influence processes', and 'cognitive instrumental processes'.

The 'social influence processes' refer to three interlinking factors: 'subjective norm', 'voluntariness', and 'image' (Venkatesh & Davis, 2000, p.187). 'Subjective norm' relates to an individual's perception of whether *important* people – people they think of as significant – think they should or should not carry out a behaviour (Venkatesh & Davis, 2000, p.187). 'Voluntariness' is a variable that accounts for whether the use of the system is mandatory or voluntary (Venkatesh & Davis, 2000, p.188). 'Image' relates to the user's status within a social group and whether the use of the technology will enhance their standing within this group (Venkatesh & Davis, 2000, p.189).

TAM2 also proposes a list of 'cognitive instrumental processes', which includes 'job relevance', 'output quality', 'result demonstrability', and 'perceived ease of use' (Venkatesh & Davis, 2000, p.190-191).

According to this model, a user's judgement about the usefulness of a DBCI in supporting a behaviour change attempt ('perceived usefulness') will be influenced by whether the intervention aids the behaviour change ('job relevance'); whether it is better than other

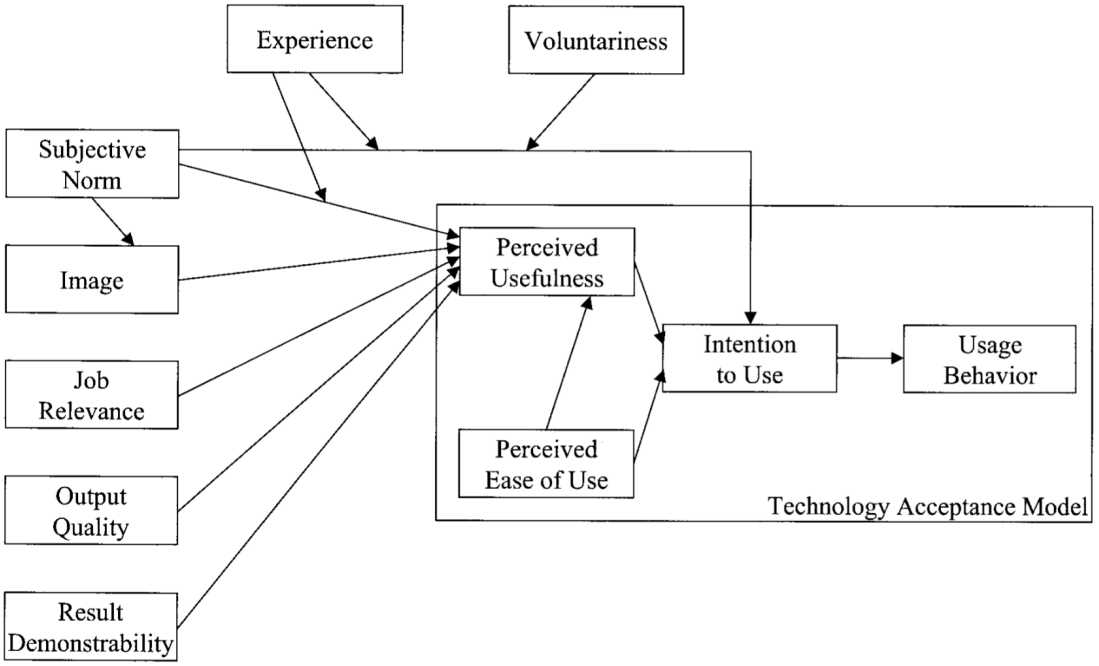

Figure 5.2: 'The Extension of the Technology Acceptance Model (TAM2)' taken from Venkatesh & Davis (2000, p.188)

apps or websites ('output quality'); and whether the user associates their behaviour change successes with the DBCI usage ('result demonstrability') – i.e., the intervention effectiveness. 'Perceived ease of use' also feeds straight into 'perceived usefulness'; a simpler system will encourage usage and increase job performance.

TAM2 also includes an 'experience' factor which could also be relabelled as 'usage of the system over time'. This factor does not refer to the user's experience or the multitude of elements explored within the UX field but instead refers to the impact of time on particular constructs.

In addition to specifying the constructs that feed into 'perceived usefulness', TAM2 also raises the issue of change over time. For example, the model shows that 'subjective norm' is influenced by time spent on the intervention. Venkatesh & Davis (2000) found that once a user becomes familiar with the system – its strengths and weaknesses – they are less impacted by social influences. Therefore regardless of the recommender, a system must produce the required outcome if it is going to be adopted long-term. As a result, researchers should consider that time may have an influence on other factors relating to disengagement.

Some of the model constructs are less relevant for a DBCI context, such as 'voluntariness' and 'image'. DBCI usage within research is voluntary and therefore this factor is unlikely to have a moderating influence on adoption. The question of voluntariness is addressed by UTAUT2. In addition, the use of a DBCI is often private and therefore unlikely to contribute to a user's 'image', except perhaps in the context of recommendations. So a

user is more likely to accept a DBCI if it has been recommended by a peer, which could in turn impact their social 'image'.

TAM2 explains a number of factors that may impact a user's perception of 'usefulness' which, if poorly addressed, are likely to lead to digital disengagement. This model also encourages researchers to consider the impact of time on disengagement factors. Researchers may need to collect disengagement data at different points on the timeline of usage to fully understand the impact of certain factors.

5.1.1.3 The Determinants of 'Perceived Ease of Use' in Relation to TAM (TAM2b)

Venkatesh (2000) explores the determinants of 'perceived ease of use' in his 'Determinants of Perceived Ease of Use' Model (TAM2b). He separates these into two groups: 'anchors' and 'adjustments' (see Figure 5.3). 'Anchors' are specific to the user and independent of the system in use. In comparison, 'adjustments' are directly shaped by the user's interactions with the specific system, which are modified over time.

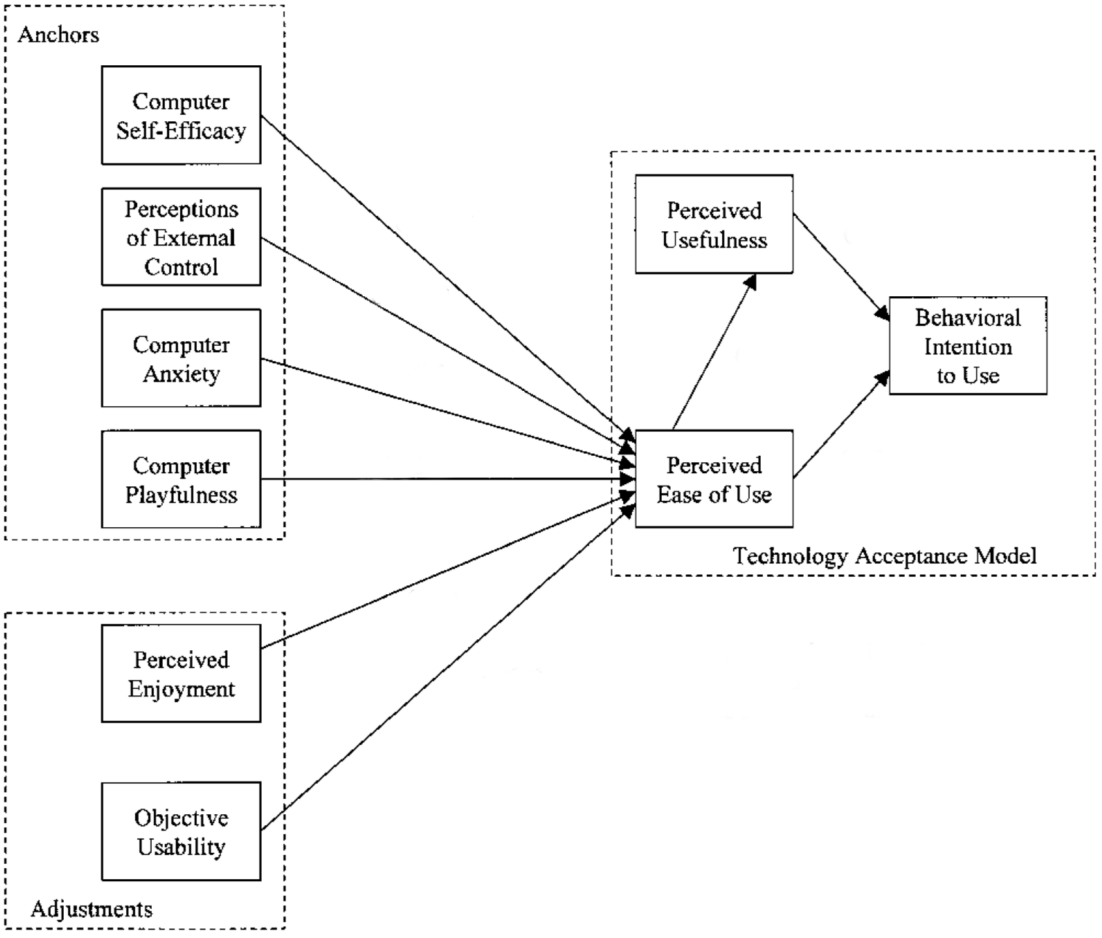

Figure 5.3: 'Determinants of 'Perceived Ease of Use" adapted from Venkatesh (2000, p.346)

The four anchors relate to control ('computer self-efficacy', 'facilitating conditions'), intrinsic motivation ('computer playfulness'), and emotion ('computer anxiety') (Venkatesh, 2000, p.346). As the user starts to use the system, the system-specific 'perceived ease of use' will be anchored in these general four constructs but will adjust according to the system-specific 'objective usability' and 'perceived enjoyment' (Venkatesh, 2000, p.346).

Venkatesh (2000, p.346) conceptualises 'control' as situational barriers or facilitators of behaviour. 'Computer self-efficacy' (internal control) relates to the individual's belief in their ability – and knowledge – to use the technology to complete the required task (Venkatesh, 2000, p.347). 'Facilitating conditions' (external control) refers to the availability of organisational and technical resources required to use the system (Venkatesh, 2000, p.347).

'Computer anxiety' is the apprehension or fear felt by an individual when faced with technology (Venkatesh, 2000, p.349). This anxiety can be both cognitive (negative expectations) and emotional (negative physiological responses) (Venkatesh, 2000, p.349). 'Computer playfulness' refers to the user's intrinsic motivation to use a system; the enjoyment or pleasure felt during use (Venkatesh, 2000, p.348). Venkatesh (2000) explains that 'playful' individuals may underestimate the effort of learning a system because they enjoy the process of discovery and challenge.

'Objective usability' uses the actual level of effort required for task completion – rather than the perception of effort – to compare different systems with similar functionality. 'Perceived enjoyment' is the application of a user's individual level of 'computer playfulness' to the specific system.

This model explains that users bring personal and unique variables into technology adoption. For example, an individual's 'computer self-efficacy' will affect how confident they feel in using the DBCI to support their behaviour change attempt. This factor could therefore affect whether an individual adopts the DBCI.

However, the model also has its limitations when applying it to DBCI research as some of the determinants need to be expanded for this context. For example, there may be other motivations in addition to 'computer playfulness' that may encourage usage – such as seeing behaviour change results or generated feelings of control (or empowerment) over an illness. Equally 'technical resources' could refer to the guidance or support offered within the DBCI itself or through additional material. If DBCIs are going to reduce the work-load of healthcare professionals, it is important that they offer the required support or user manuals.

Furthermore, Venkatesh (2000, p.349) claims that the 'computer anxiety' construct will *capture* the emotional aspect of usage. I do not dispute that 'computer anxiety' is likely to affect technology adoption. However, this implies a very specific emotional response to a system and it could be argued that conceptualising 'emotion' in this way could be

limiting. It might lead to an oversight of other emotional responses that equally impact 'perceived ease of use', such as frustration during use. Additionally, there are some factors which are not relevant for the DBCI setting, such as the organisation's resources – part of 'facilitating conditions'.

In a similar way to models from UX, this model suggests that any interaction with a technology is dependent on certain traits of the user, and therefore explores factors that relate to 'perceived ease of use'. The disengagement framework therefore needs to encourage the collection of user-specific data to ensure usage is understood within the context of that individual.

5.1.1.4 Technology Acceptance Model 3 (TAM3)

'The Technology Acceptance Model 3' (TAM3) combines the previous TAMs and three theoretical extensions (Venkatesh & Bala, 2008) (see Figure 5.4). These extensions relate to the effect of 'experience' on relationships within the model, relationships that were confirmed through various studies (Venkatesh & Bala, 2008, p.287).

Firstly, the impact of 'perceived ease of use' on 'perceived usefulness' increases with 'experience' – i.e., usage over time (Venkatesh & Bala, 2008, p.286). Secondly, the effect of 'perceived ease of use' on 'behavioural intention' reduces over time (Venkatesh & Bala, 2008, p.290). This is possibly because during the period of usage individuals become more familiar with the system – maybe learning their own ways to use it – so reducing the impact of 'ease of use' on their behavioural intention. Thirdly, Venkatesh & Bala (2008, p.290) believe that 'computer anxiety' impacts initial judgements of 'perceived ease of use' but that this decreases over time.

This model reiterates the dependencies between different adoption and acceptance factors and how these change with usage, over time. If 'computer anxiety' impacts initial acceptance then designers may wish to provide more guidance or introductory features within the DBCI to prevent anxious users from digitally disengaging. Furthermore, DBCI researchers should be aware of 'ease of use' at initial stages of adoption and how these perceptions may influence comparisons with other systems.

Venkatesh & Bala (2008) also claim that TAM3 is a good theoretical contribution due to its 'comprehensiveness' and potential for 'actionable guidance'. Venkatesh & Bala (2008, p.302) use Whetten's (1989) definition of 'comprehensiveness' as including all relevant factors. However, in Venkatesh & Bala's (2008) paper they also propose a theoretical framework (see Figure 5.5) that is an accumulation of TAM-related research. They explain that 'individual differences' include personality and demographic influences, factors which are not included in TAM3. It is therefore misleading to suggest that TAM3 qualifies as a 'comprehensive' model.

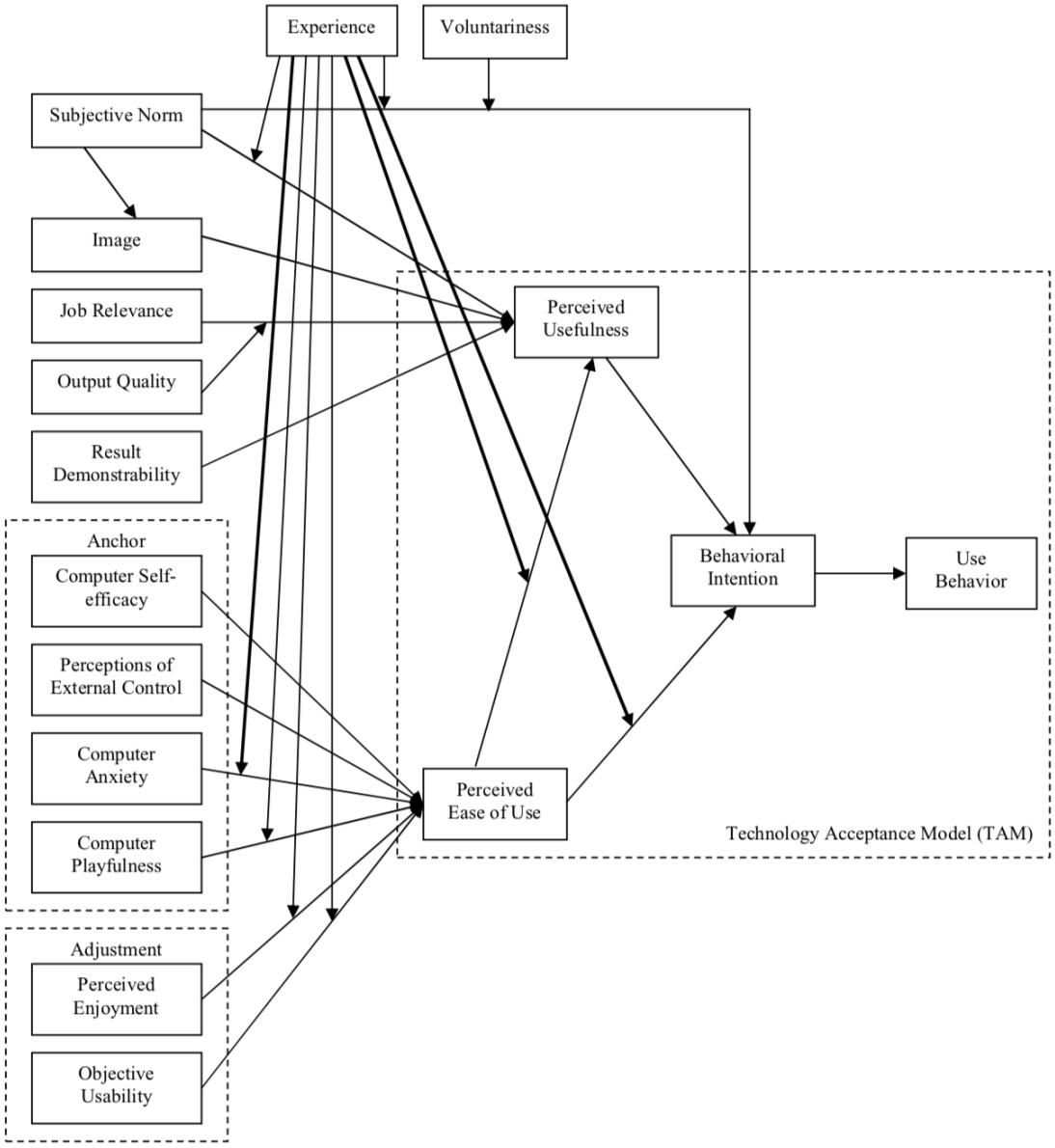

Figure 5.4: The 'Technology Acceptance Model 3 (TAM3)' taken from Venkatesh & Bala (2008, p.280)

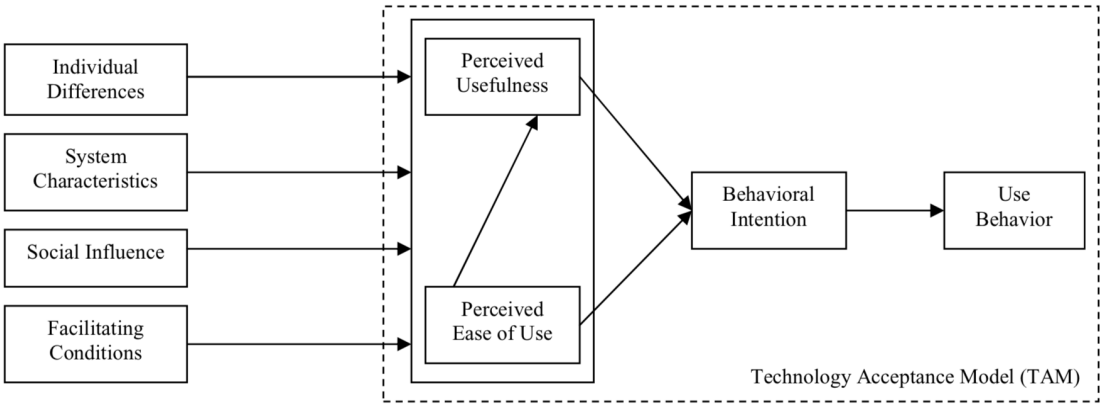

Figure 5.5: 'Theoretical Framework' taken from Venkatesh & Bala (2008, p.276)

Like all TAM versions the organisational context produces a task-focused model. However, it is important to remember that a user will not adopt technology that does not support their behavioural goal – regardless of whether they are task-focused or intrinsically motivated. Nonetheless, TAM3 incorporates a number of interesting factors for disengagement especially 'perceived ease of use', 'perceived usefulness', and the role of 'experience' (usage over a period of time). Furthermore, it emphasises the dependencies between different factors and the impact of user-specific variables on adoption. All these constructs provide insight and potential triggers for early digital disengagement.

5.1.2 Technology Acceptance Model for Mobile Services (TAMM)

The 'Technology Acceptance Model for Mobile Services' (TAMM) (Kaasinen *et al.*, 2011) is an extension of the original TAM framework (Davis *et al.*, 1989) and is supported by over 200 test users. It has not been included in the TAM subsection (see Section 5.1.1) because it was developed by a different group of researchers.

During their research, Kaasinen *et al.* (2011) could not match their research findings to TAM and therefore produced a mobile specific version of the framework (see Figure 5.6). It is unclear why Kaasinen *et al.* (2011) chose to extend the original TAM framework rather than the most recent version (TAM3).

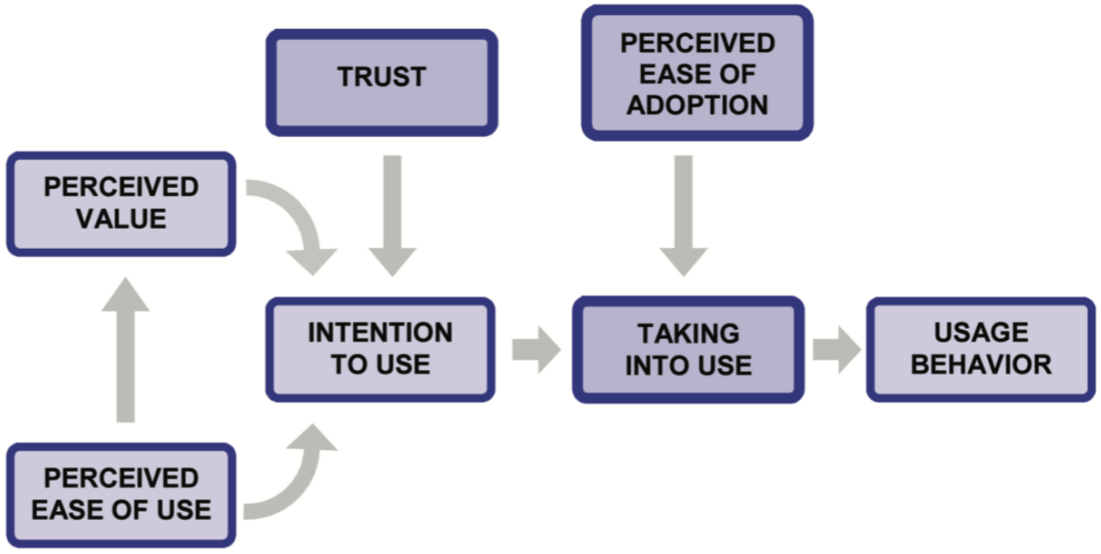

Figure 5.6: 'Technology Acceptance Model for Mobile Services' taken from Kaasinen *et al.* (2011, p.85)

In addition to the original TAM constructs ('perceived ease of use', 'intention to use', and 'usage behaviour'), Kaasinen *et al.* (2011) added two constructs: 'trust', and 'ease of adoption'. They also redefined 'perceived usefulness' as 'perceived value'.

'Perceived ease of use' carries the same definition as before and emphasises design considerations for a mobile device, such as screen, keyboard, memory, and battery life (Kaasinen *et al.*, 2011, p.85). In addition, they propose that the benefit of the location-based functionality and personalisation may be outweighed by the impact on 'perceived ease of use'.

The researchers felt that the term 'perceived usefulness' was potentially too simplistic and did not consider the level of user motivation required to acquire a mobile service, and instead proposed the term 'perceived value'. They proposed a number of factors that feed into 'perceived value', including the key features and the cost of the service (Kaasinen *et al.*, 2011, p.86). They also found that users do not tend to evaluate a service based on the entirety of the features on offer but instead on the feature that helps them achieve their particular objective or task (Kaasinen *et al.*, 2011, p.87).

In this context, there is a useful discussion around the concept of 'trust' by which the authors refer to the user's belief that the system and provider is reliable, that the service can be easily controlled, and that it will not misuse their data (Kaasinen *et al.*, 2011, p.88). They found that this was an important factor for adoption, especially in relation to location-based services and privacy.

Finally, Kaasinen *et al.* (2011) attempt to address the gap between 'intention to use' and 'usage behaviour' by adding an additional stage referred to as 'taking into use'. This stage is impacted by 'perceived ease of adoption'. 'Perceived ease of adoption' is determined by how easy the user thinks the service will be to download and set up, and how it will interact and behave with any of their pre-existing services. Tailoring services – using personalisation or customisation – can also increase the initial set up burden for the user and have an impact on adoption.

TAMM usefully explores the factors between intention and usage that explain why an individual may disengage. 'Perceived ease of adoption' is particularly relevant for DBCI because individuals are likely to use a range of applications which they may want to integrate with the DBCI. The addition of the idea of 'trust' is also interesting because whilst DBCI development often considers content credibility for behaviour change, it rarely pays attention to technological implications such as privacy or data misuse. These concerns are particularly relevant when dealing with sensitive data such as medical symptoms or related medication.

However, the model specifically focuses on the acceptance of mobile services but does not identify long-term usage issues. It can therefore only identify early digital disengagement factors. Nonetheless, the inclusion of 'trust' in technology and 'perceived ease of adoption' add new considerations for DBCI disengagement research.

5.1.3 Unified Theory of Acceptance and Use of Technology Models

The 'Unified Theory of Acceptance and Use of Technology' (UTAUT) Model was originally developed in 2003 to understand acceptance and usage in an organisational setting (Venkatesh *et al.*, 2003). Over the years it has been adapted and extended but Venkatesh *et al.* did not officially develop UTAUT2 until 2012. The following two sections explore the various constructs in these two models.

5.1.3.1 Unified Theory of Acceptance and Use of Technology (UTAUT)

Venkatesh *et al.*'s (2003) 'Unified Theory of Acceptance and Use of Technology' (UTAUT) (see Figure 5.7) was constructed from an analysis of eight different models and theories of usage: 'Theory of Reasoned Action' (TRA), TAM (and TAM2), 'Motivational Model' (MM), 'Theory of Planned Behaviour' (TPB), 'Combined TAM and TPB' (C-TAM-TPB), 'Model of PC Utilisation' (MPCU), 'Innovation Diffusion Theory' (IDT), and the 'Social Cognitive Theory' (SCT). Although the components of UTAUT are supposedly the combination of eight different theories of usage, UTAUT seems to closely resemble TAM constructs.

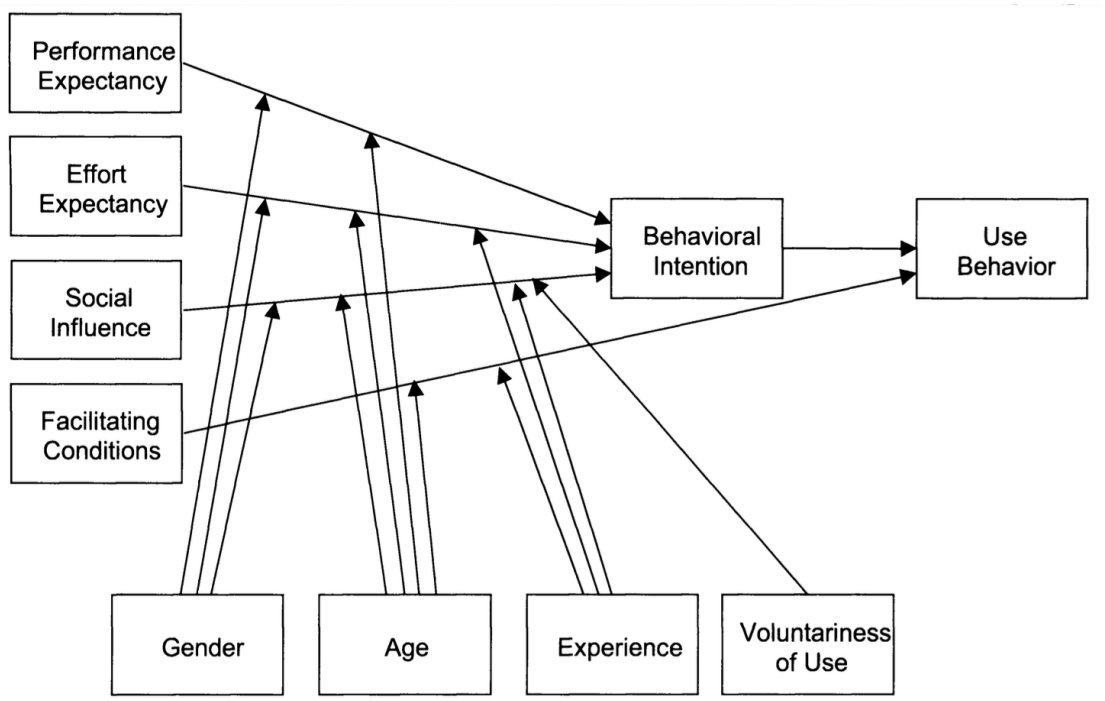

Figure 5.7: 'Unified Theory of Acceptance and Use of Technology (UTAUT)' taken from Venkatesh *et al.* (2003, p.447)

'Performance expectancy' is the degree to which an individual believes the system will aid their task performance (Venkatesh *et al.*, 2003, p.447), and seems to equate to 'perceived usefulness'. 'Effort expectancy' is the user's perception of the effort required

to use the system (Venkatesh *et al.*, 2003, p.450), which is similar to 'perceived ease of use'. Parallels such as these continue with the majority of the constructs. However, 'age' and 'gender' have been added to the model as additional moderating factors, as a result of supporting empirical evidence.

UTAUT does contain one additional relationship that is not present in any of the other TAM models, which is a link between 'facilitating conditions' and 'use behaviour' (Venkatesh *et al.*, 2003, p.447). On the other hand, 'facilitating conditions' is defined in the same way as it is in TAM3, referring to organisational and technical support.

Due to the similarities between the constructs in UTAUT and the TAMs, this model does not appear to contribute significantly to disengagement research, except in acknowledging the role of demographic variables.

5.1.3.2 Extending the Unified Theory of Acceptance and Use of Technology (UTAUT2)

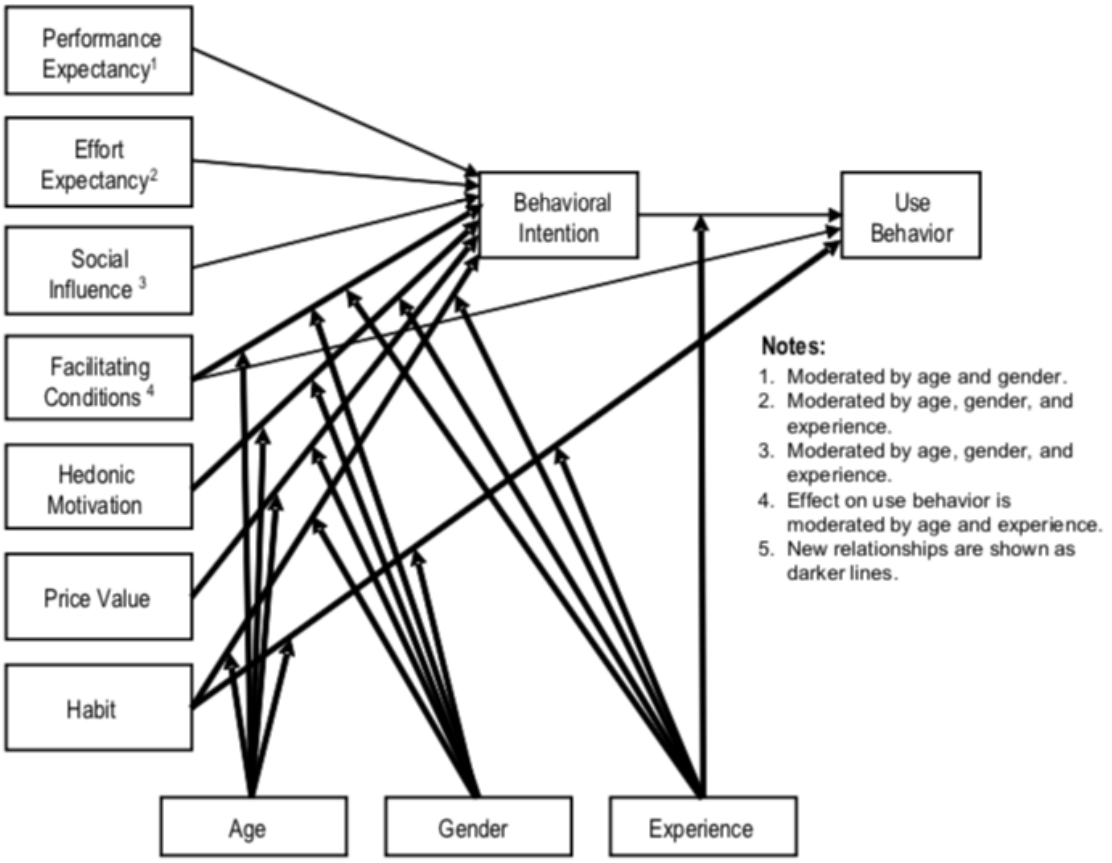

Figure 5.8: 'Extending the Unified Theory of Acceptance and Use of Technology (UTAUT2)' taken from Venkatesh *et al.* (2012, p.160)

Venkatesh *et al.* (2012) extended UTAUT to explore the constructs of user acceptance in a *consumer* rather than an *organisational* setting. The 'Extending the Unified Theory of Acceptance and Use of Technology' (UTAUT2) Model removes 'voluntariness of use' but includes three new constructs: 'hedonic motivation', 'price value', and 'habit' (see Figure 5.8).

'Voluntariness of use' was removed because UTAUT2 is already modelling usage in a voluntary context – a consumer setting – making this moderating factor redundant (Venkatesh *et al.*, 2012, p.159). 'Hedonic motivation' – 'perceived enjoyment' in TAM3 – refers to the fun or pleasure derived from using a technology (Venkatesh *et al.*, 2012, p.161). 'Price value' is the trade off between cost and perceived benefit of the technology. 'Habit' can be defined in a number of ways but Venkatesh *et al.* (2012, p.161) define it as the 'perceptual construct that reflects the results of prior experiences'. 'Experience' follows the same definition as TAM3 – i.e., an individual's opportunity to use the technology, which is operationalised as the time since first usage.

The context of this model aligns more naturally with the voluntary nature of DBCI usage and therefore its inclusion of motivation as a significant factor should be considered for the disengagement framework. Additionally, demographic variables and past experiences – 'habit' – may also impact early digital disengagement.

5.1.4 Identified Factors

Table 5.1 summarises the digital disengagement factors that have been identified from these acceptance and adoption models, including factors identified in the published descriptions. As with the models discussed in the Behaviour Change literature, these models (and their associated publications) use slightly different terms to define the same or similar concepts. Synthesising these factors into one table led to the identification of similar terms, which were grouped under an appropriate label in the 'Emergent Factors' column. When a publication used a different term to the one listed, the tick has been bracketed; for example see 'intervention - usability'.

The 'Technology Acceptance Model' (TAM) (and TAM2, TAM2b, and TAM3) and the 'Technology Acceptance Model for Mobile Services' (TAMM) explain the importance of 'perceived ease of use' in technology acceptance. This is defined as 'the degree to which the prospective user expects the target system to be free of effort' (Davis *et al.*, 1989, p.985). Although the 'Unified Theory of Acceptance and Use of Technology' (UTAUT) (and UTAUT(2)) use a different term ('effort expectancy'), it is defined in a very similar way to 'perceived ease of use', as the 'degree of ease associated with the use of the system' (Venkatesh *et al.*, 2003, p.450). These two terms, and their related definitions, can simply be conceptualised as the *usability* of the intervention.

Table 5.1: Summary table of technology acceptance and adoption models illustrating the overlap between digital disengagement factors

Emergent Factors	**1.TAM(2,2b,3)**	**2.TAMM**	**3.UTAUT(2)**
Age			✓
Competing Apps & Websites	(✓)		
Demographics	(✓)		
Gender			✓
Image	✓		
Intervention - Content		✓	
Intervention - Control		✓	
Intervention - Ease of Adoption (Perceived)		✓	
Intervention - Effectiveness (Task)	(✓)	(✓)	
Intervention - Enjoyment (Perceived)	✓		(✓)
Intervention - Expectations	(✓)		
Intervention - Functionality		(✓)	
Intervention - Interactivity		✓	
Intervention - Navigation		✓	
Intervention - Perceptions	(✓)		(✓)
Intervention - Social Network		(✓)	
Intervention - Tailoring		(✓)	
Intervention - Trust		✓	
Intervention - Usability	(✓)	(✓)	(✓)
Intervention - Usefulness (Perceived)	✓	(✓)	(✓)
Intervention - Value (Perceived)		✓	(✓)
Intervention - Voluntariness of Use	✓		(✓)
Personality	(✓)		
Self-efficacy - Technical	(✓)		
Social Norms	(✓)		(✓)
Support	✓	✓	(✓)
Usage - Barriers	(✓)		(✓)
Usage - Emotions	(✓)		
Usage - Facilitators	(✓)		(✓)
Usage - Habit			✓
Usage - Intention	✓	✓	✓
Usage - Job Relevance	✓		
Usage - Motivation	(✓)		
Usage - Motivation (Hedonic)	(✓)		✓
Usage - Past Experiences	(✓)		(✓)

The concept of 'intervention - usability' also appeared in the models from the previous chapter – such as Oinas-Kukkonen's (2013) requirement that Behaviour Change Support Systems (BCSSs) should be 'easy to use' (from Section 4.2.3). Furthermore, simply using the term usability means disengagement researchers will consider both the perceived and actual effort required to achieve a task, further incorporating the additional 'objective usability' component from TAM2b (and TAM3) (Venkatesh, 2000, p.350-351).

TAM(2, 2b, 3) and UTAUT(2) also discuss the impact of 'facilitating conditions' on technology acceptance. In the work setting this is defined as the support provided by the organisation to facilitate the use of IT (Venkatesh & Bala, 2008, p.276). However in the consumer setting, the 'Extending the Unified Theory of Acceptance and Use of Technology' (UTAUT2) Model defines it as the 'consumers' perceptions of the resources and support available to perform a behaviour' (Venkatesh *et al.*, 2012, p.159). Neither of these contexts accurately represent a DBCI user. However, 'facilitating conditions' can be redefined in this context as the ways in which an individual feels their DBCI usage is being facilitated, 'usage - facilitators'. Venkatesh *et al.* (2003, p.453) further explain that 'facilitating conditions' also includes the removal of barriers and hence the inclusion in the table of 'usage - barriers'.

These examples – 'intervention - usability', 'usage - facilitators', and 'usage - barriers' – illustrate the process of identifying variables across models and linking related terms. Table 5.1 is the outcome of this synthesis. These emergent factors represent the different influences that affect whether an individual chooses to accept and/or adopt a new technology – in this case the DBCI. This table will be combined with the tables from the other literature sections to generate the disengagement framework.

5.1.5 Summary: Technology Adoption and Usage Models

This section has explored the most commonly used and cited models of adoption and acceptance, which provide potential factors for early digital disengagement. These models seem to identify a number of key aspects of technology acceptance – although some use slightly different terminology – including 'perceived usefulness', 'perceived ease of use', and 'experience'. The numerous extensions and citations of TAM and UTAUT models suggest that these factors are worth exploring within disengagement research. Table 5.1 shows the digital disengagement factors that have been identified from these acceptance models.

These models also explore the effect of time on various variables. For example, Venkatesh & Davis (2000) found that the impact of 'social influences' decreases over time. The 'experience' factor – period of time spent using the technology – also affects a number of other interacting factors. Therefore, there may be factors which are not identified in these acceptance models but that play a role in disengagement during longer term use.

As a result, researchers may need to collect data at various time intervals to understand the impact of experience on usage.

These models portray fairly simple relationships between 'behavioural intention' and 'use behaviour'. However, the 'intention-behaviour gap' is a well-known phenomenon, which states that there is a significant gap between intention and behaviour (Sheeran, 2002). There are plenty of theories about this gap. Ryan & Deci (2000) suggest it is the result of a lack of motivation, Fogg (2009) argues that a lack of triggers plays a significant role, and Sheeran & Webb (2016) suggest that the gap can result from the way in which the behavioural goals are framed. These pieces of research are extensive but they all confirm that these acceptance models appear to underplay the complexity of this process. Therefore, although these acceptance models provide some insight into adoption (or early digital disengagement), some may not be as 'comprehensive' as they claim. Kaasinen *et al.* (2011, p.104) also acknowledges that TAMM may be useful for initial adoption but further research is required to understand longer term use. For this reason, the following sections explore UE and UX models to better understand the factors that might affect longer term usage or disengagement.

5.2 User Engagement (UE) Models

This section explores the models that attempt to conceptualise engagement: O'Brien & Toms' (2008) 'Model of Engagement' (MoE), Kim *et al.*'s (2013) 'Mobile User Engagement Model' (MoEN), and Sutcliffe's (2016, p.109) 'Model of Cognitive Factors Influencing User Engagement' (MCFIUE).

These models were identified through a series of Google Scholar searches, which included the terms 'user engagement' AND 'model' AND 'technology'. The search was limited to a six year period (2010-2016). This search identified a paper (O'Brien & Toms, 2010), which made reference to a highly cited earlier model 'Model of Engagement' (MoE) (O'Brien & Toms, 2008). This was subsequently included. Models were excluded if they focused specifically on one domain rather than technology as a whole, for example e-learning, social media, or MOOCS. These exclusion criteria were designed to avoid the inclusion of factors that were too domain-specific and not related to general use of technology. In addition, the publication had to include a definition or explanation of 'engagement' to ensure the relevance of the model.

O'Brien and Sutcliffe have both written extensively on the topic of engagement. Their models are interesting because they approach User Engagement (UE) from distinctive perspectives. O'Brien & Toms (2008) for example, propose a process-based model which looks at the different attributes of the engagement process. Sutcliffe's (2016) model specifically explores the cognitive factors relating to engagement rather than presenting engagement as a process.

Kim *et al.*'s (2013) model has been included because it specifically focuses on engagement with mobile technology, which is important for DBCI apps. Additionally, this model explores the relationship between motivation, value, and satisfaction; constructs identified as potentially influential in early digital disengagement (see Section 5.1).

These models show the diverse nature of UE research and push beyond the concept that engagement is simply about usage, or behaviour. The focus on the *user* provides insight into why an individual may choose to digitally disengage from a DBCI. This user-focus will complement the UX models (explored in the next section) which tend to focus more on the *technology*, providing a well-rounded understanding of digital disengagement.

5.2.1 Model of Engagement (MoE)

O'Brien & Toms (2008) propose a 'Model of Engagement' (MoE) which separates the engagement process into a series of stages: 'point of engagement', 'engagement', 'disengagement', and 're-engagement' (see Figure 5.9). The model identifies a number of attributes for each stage; not exhaustive lists but rather the 'most significant' attributes (O'Brien & Toms, 2008).

They based their questions and analysis on McCarthy & Wright's (2004a) 'Threads of Experience', defined as: 'compositional', 'spatiotemporal', 'emotional' and 'sensual' (see Section 5.3.1). Interviewees were encouraged to tell *their* story from beginning to end (compositional), paying attention to subtasks, their physical environment and their awareness of themselves (spatiotemporal). Statements were analysed by exploring sentiment – positive, negative or neutral emotions (emotional) – and system qualities – appearance and interactivity with the system (sensual). This analysis led to the depiction of engagement as a process.

This model identifies a number of disengagement specific attributes, including 'usability', 'challenge', 'affects', 'perception over time', and 'interruptions'. These provide a good starting point for disengagement research. However, in this context *disengagement* specifically refers to a *quality* of an interaction rather than particular actions which lead to non-usage. Therefore these attributes may not be linked directly to non-usage but rather indicate the level of engagement *within* the interaction. This model does not clarify when disengagement factors are likely to lead to the termination of usage rather than a lower level of intensity within an interaction.

This research also suggests that context is an important consideration for technology interaction. The model was developed from a series of 19 semi-structured interviews exploring engaging experiences relating to online shopping, Web searching, educational webcasting or gaming. Although O'Brien & Toms (2008) did not aim to compare the four contexts of use, they did find differences between the groups. For example, video gamers enjoyed more challenging experiences and found it harder to disengage. It is therefore

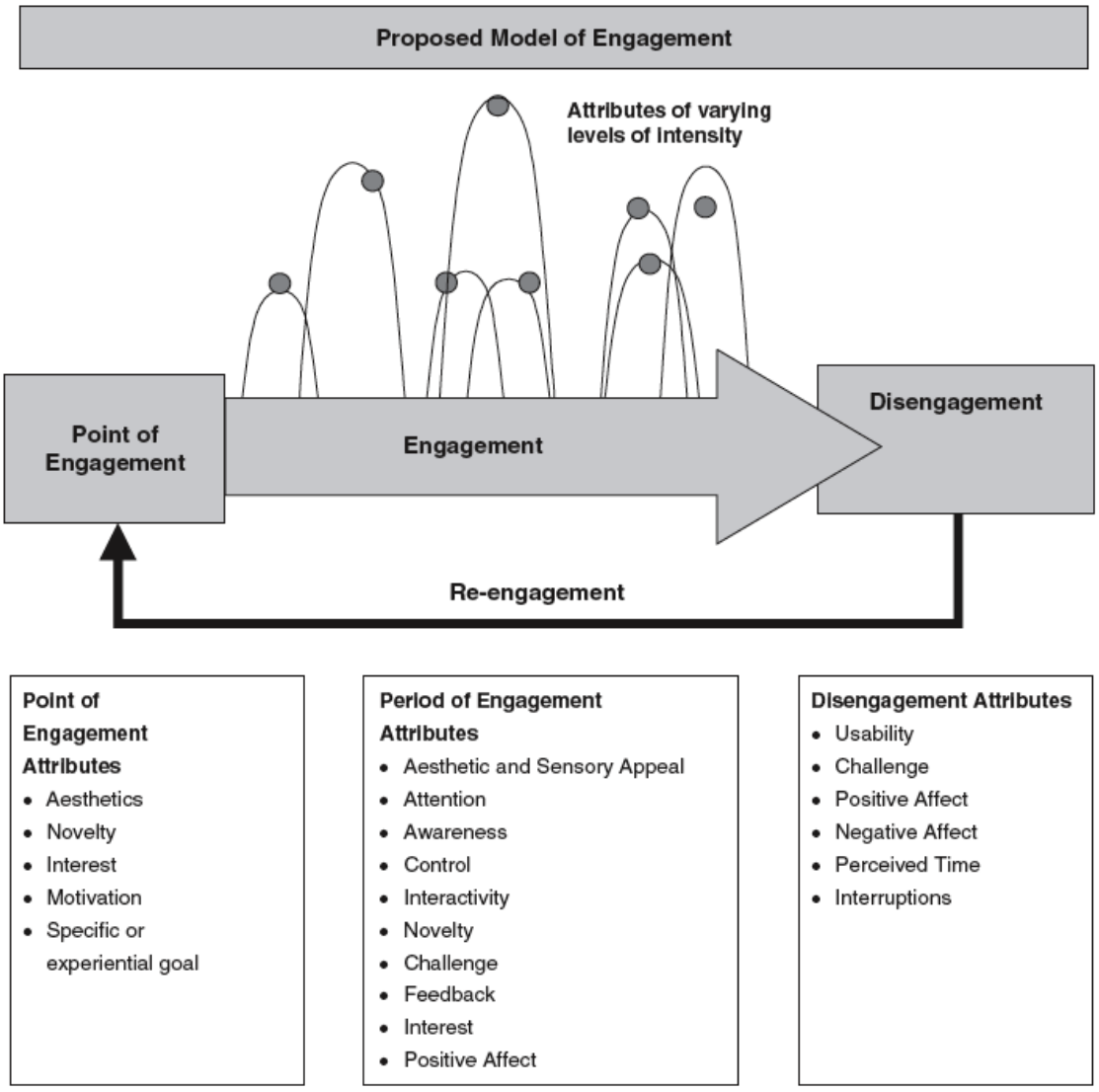

Figure 5.9: 'Model of Engagement' taken from O'Brien & Toms (2008, p.949)

important to consider which disengagement attributes specifically affect a DBCI user and whether these are specific to the behaviour being addressed.

This model aims to explain the engagement phenomenon. However, it would be challenging to use it within the development process. Many of these attributes are subjective – such as 'novelty' – which may be difficult to translate into design. The attribute lists are also not exhaustive and the model does not explain how to identify when a user is in each stage of the engagement process.

The model provides several 'disengagement' attributes which may be explored within research, such as 'usability', 'affects', and 'interruptions'. Furthermore, the lack of an engagement attribute – such as 'interactivity' or 'control' – might also lead to disengagement and therefore all these attribute lists should be considered for the framework.

5.2.2 Mobile User Engagement (MoEN)

Kim *et al.*'s (2013) 'Mobile User Engagement Model' (MoEN) proposes a relationship between a 'user's motivation', 'perceived value', and 'satisfaction'; all contributing to the engagement intention of an individual (see Figure 5.10).

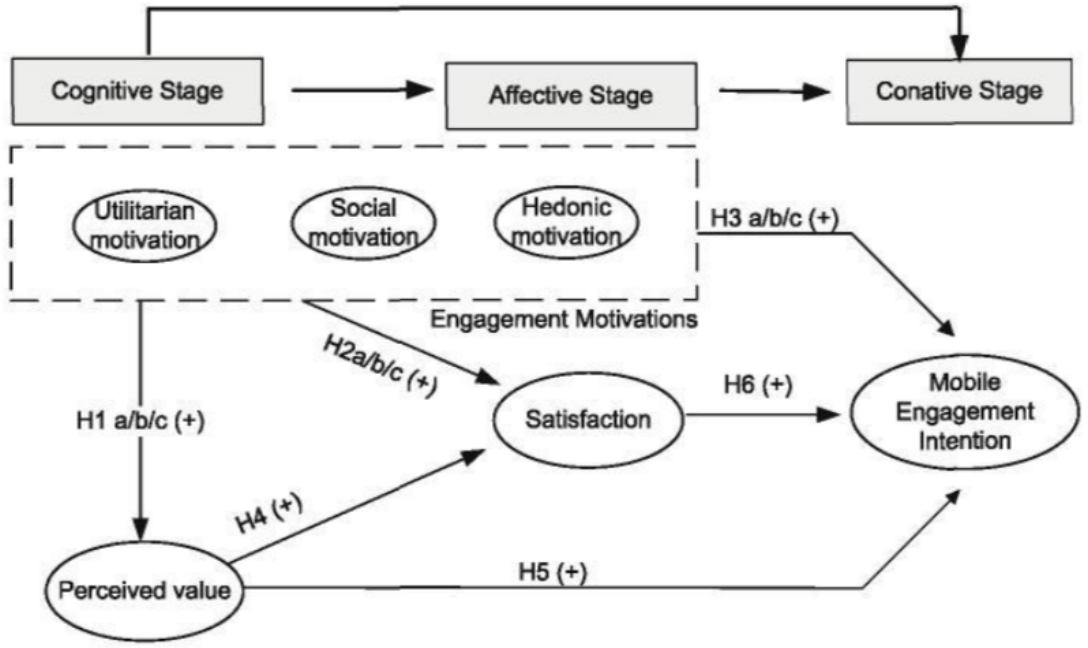

Figure 5.10: 'Mobile User Engagement' (MoEN) taken from Kim *et al.* (2013, p.363)

MoEN was designed to explain how or why a user engages with a mobile technology. It passes beyond initial acceptance of mobile technology to explain how a user's motivation can impact their intention for continued use (Kim *et al.*, 2013, p.362-263). The model segments motivation into three forms: 'utilitarian' (usefulness, efficiency), 'social' (connecting and sharing with others) and 'hedonic' (fun, enjoyment). According to previous research – by Kim *et al.* (2007) – hedonic consumption is the most important factor for continued use of smartphones and this should be considered within DBCI disengagement research.

This model is interesting because it separates engagement motivations into categories. These types of motivation influenced 'perceived value', 'satisfaction', and 'engagement intention' to varying degrees. However, all of these positively influenced engagement intention in some way. Users may have different motivations for using a DBCI and this model encourages disengagement researchers to explore these different categories of motivation.

However, this model explains engagement intention for using mobile technology in general terms, rather than in relation to a specific app or website on the platform. Other models suggest that engagement is context specific so these three motivations may not

all be relevant for a DBCI setting. Furthermore, this model only discusses 'engagement intention' and does not extend to actual behaviour, thereby limiting its usefulness. It will be important to explore which are the prominent types of motivation for DBCI usage.

Although this model provides potential factors pertinent to a user's intention to engage, the lack of specific task orientation or context limits its usefulness. However, it is a good starting point and exploring these three engagement motivations within a DBCI context may provide some insight into disengagement. In addition, this model identifies a relationship between motivation, perceived value and satisfaction; all considerations for disengagement research.

5.2.3 Model of Cognitive Factors Influencing User Engagement (MCFIUE)

Sutcliffe (2016, p.110) presents a 'Model of Cognitive Factors Influencing User Engagement' (MCFIUE) with a focus on the concept of interaction (see Figure 5.11). 'Interaction' refers to the purposeful 'dialogue' between a user and machine, which can simply be fun (Sutcliffe, 2016, p.109).

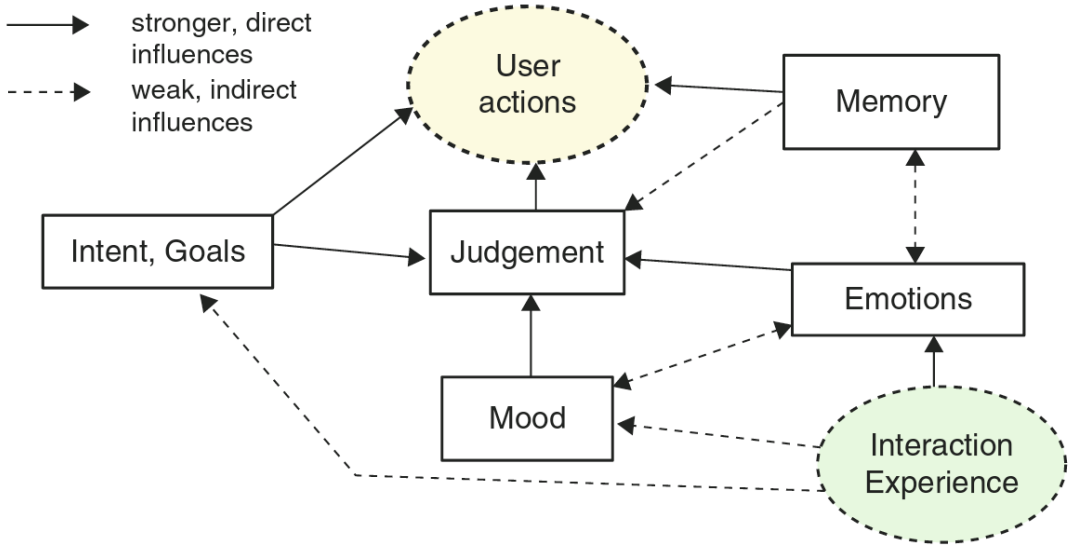

Figure 5.11: 'Model of Cognitive Factors Influencing User Engagement' taken from Sutcliffe (2016, p.110)

Lalmas *et al.* (2014, p.3) define UE as 'the *emotional*, *cognitive*, and *behavioral* experience of a user with a technological resource that exists, at any point in time *and* over time'. Sutcliffe's (2016) model presents just the *cognitive* considerations in this process. Therefore, the model does not show a 'point' or 'process' of engagement but the interrelating components that contribute to a user's cognitive experience of engagement.

Sutcliffe's (2016) model states that a user's actions – in this case the use of the technology – is influenced by their 'intentions' or 'goals', 'memories' and 'judgements'. A user's perception of the design is influenced by the aesthetics (how the product appears to the user), which combined with the interaction experience (use of a product) produces an emotional response. These emotions in turn influence the user's 'judgements'. A user's arousal mechanism and 'emotions' combine to form 'moods', which can last for hours or days and in turn affect their 'judgements'. 'Memories' are formed from past experiences with the technology. Therefore, a bad design or poor experience with the technology can lead to a bad mood which leads to a negative memory or judgement about the product.

In addition, individuals tend to remember the specific situation or cause that evoked a negative emotion (such as poor usability), whereas positive experiences are also remembered, but not in such detail (Sutcliffe, 2016, p.110). Therefore, a user might remember an overall good experience with technology but they are likely to specifically remember the instances of frustration caused by poor navigation or misleading aesthetics.

This model provides interesting insights into the components of UE and the influences that these have on future actions. This work also provides further justification for disengagement research as negative experiences appear to have a significant impact on judgement and future use.

This model is limited to factors relating to a user's cognition and therefore does not explore the factors relating to specific real-time usage. The work also discusses the need for good aesthetics and interactivity but it does not explain what forms these should take. This model clearly highlights the importance of emotions, the interaction, goals and memory on the likelihood for use and these will be considered in the proposed disengagement framework.

5.2.4 Identified Factors

Table 5.2 presents the various disengagement factors identified in this section. The models discussed above have explored factors of engagement from different aspects of the user's perspective, such as their emotional, cognitive, and behavioural experience of technology (Lalmas *et al.*, 2014). For example, Kim *et al.* (2013) refers to the user's social motivation rather than stating the social features of the technological design. This is another example of models framing terms differently when essentially referring to the same factor: a user's need for social interaction and support. Therefore this could be written in the table as 'usage - motivation (hedonic)' from the perspective of the user or as 'intervention - social network' from the perspective of the DBCI design.

Table 5.2: Summary table of UE models illustrating the overlap between digital disengagement factors

Emergent Factors	**1. MoE**	**2. MoEN**	**3. MCFIUE**
Ability	✓		
Competing Apps & Websites	(✓)		
Emotions	(✓)	(✓)	(✓)
Intervention - Aesthetics	✓		✓
Intervention - Brand		✓	
Intervention - Challenge	✓		
Intervention - Content	✓		
Intervention - Control	✓		
Intervention - Effectiveness	✓		
Intervention - Enjoyment	✓	✓	(✓)
Intervention - Expectations	✓		
Intervention - Feedback	✓		
Intervention - Fun	✓	✓	
Intervention - Functionality		✓	
Intervention - Interactivity	✓		✓
Intervention - Interest	✓		✓
Intervention - Judgement			✓
Intervention - Navigation			(✓)
Intervention - Novelty	(✓)		✓
Intervention - Perceptions		(✓)	(✓)
Intervention - Social Network	(✓)	(✓)	
Intervention - Tailoring	✓		
Intervention - Usability	✓	(✓)	✓
Intervention - Usefulness		✓	
Intervention - Value (Perceived)		✓	
Psychosocial		(✓)	
Usage - Attention	✓		✓
Usage - Awareness	✓		
Usage - Context	(✓)		
Usage - Efficiency		✓	
Usage - Emotions	(✓)		✓
Usage - Experience	✓		✓
Usage - Goals	✓		✓
Usage - Intention	✓	(✓)	
Usage - Interruptions	✓		
Usage - Motivation	✓	✓	

Continues on the next page ...

Emergent Factors	1. MoE	2. MoEN	3. MCFIUE
Usage - Motivation (Hedonic)		✓	
Usage - Motivation (Social)		✓	
Usage - Motivation (Utilitarian)		✓	
Usage - Past Experiences	✓		(✓)
Usage - Satisfaction		✓	
Usage - Time	(✓)		

Many of the models in this section use slightly different terminology for the same or similar concepts. Collating these factors into one table enabled the identification of similar factors, which were grouped under a label in the 'Emergent Factors' column. When a model (or publication) used a different term to the one listed, the tick is bracketed in the table. For example, all of the engagement models identified 'emotion' – in some form or other – as an influencing factor on a user's interaction with technology. This was conceptualised in two different ways: 'usage - emotions' and 'emotions', depending on the context.

The 'Model of Engagement' (MoE) identifies the presence of 'positive affect' during an engagement interaction (O'Brien & Toms, 2008). They define this as 'the emotional investment a user makes in order to be immersed in an environment and sustain their involvement in the environment' (O'Brien & Toms, 2008, p.949). In a DBCI context the 'environment' relates to the technology. The 'Model of Cognitive Factors Influencing UE' (MCFIUE) also identifies the significance of the 'emotional' response to usage. For example, 'a bad user experience will trigger emotions of frustration, anxiety and even anger' (Sutcliffe, 2016, p.110). These definitions and model components therefore illustrate the fact that usage can lead to certain emotional reactions, listed as the 'usage - emotions' factor in the table. This factor was also identified in TAM2b (from the previous section) but it was conceptualised more specifically as 'computer anxiety'[1].

Several of the models also discussed different types of emotional reactions. For example, in addition to usage related emotion, Sutcliffe (2016, p.110) also presented the idea of long-term emotion, in the form of a 'mood', which can affect an individual's judgement. A 'mood' can last for hours or days and therefore an individual could be bringing *old* emotions to their interactions with technology. Furthermore, their emotions could relate specifically to their situation rather than their technological interaction (O'Brien & Toms, 2008, p.950). In addition, the 'Mobile User Engagement' (MoEN) research explains that a user may bring pre-existing 'feelings' that they have 'toward[s] an object (smartphone)' (Kim *et al.*, 2013, p.362). These different models therefore illustrate that an individual may bring pre-existing emotions relating to other objects or situations to their interactions with the DBCI (the 'emotions' factor), and that these should

[1] Defined as 'an individual's apprehension, or even fear, when she/he is faced with the possibility of using computers' (Venkatesh, 2000, p.349).

be considered in addition to their emotional reactions to usage (the 'usage - emotions' factor).

These two examples ('emotions' and 'usage - emotions') are illustrative of the process carried out on all the model factors and their related descriptions. Table 5.2 is therefore the outcome of this synthesis. It also provides the digital factors relating to UE, and helps to explain why an individual may choose to digitally disengage.

5.2.5 Summary: UE Models

The models described in this section reflect the diverse nature of UE research. They all appear to approach UE differently – attempting to model different aspects of engagement – but all with a specific user-focus.

O'Brien & Toms (2008) propose UE as a process with a beginning and an end, listing a number of attributes for these different stages. The model specifically identified a number of disengagement attributes which will be considered for the framework. However, in this context *disengagement* may not refer to non-usage but instead relates to a lower level of interaction intensity. It is therefore unlikely to represent a definitive list of disengagement factors. O'Brien & Toms (2008) also acknowledge that this is not a exhaustive list and discovered that attributes were context dependent. This may also be true for DBCI disengagement and the framework may need to be adaptable for different types of behavioural interventions.

Exploring Kim *et al.*'s (2013) model – which focuses on 'utilitarian', 'social', and 'hedonic' motivations within a DBCI context – provides some insight into the expectations of an individual using this type of technology. This model also implies a relationship between 'motivations', 'perceived value' and 'satisfaction'; all leading to 'engagement intention' and therefore likely to influence disengagement from a DBCI.

Finally, Sutcliffe's (2016) model specifically focuses on the cognitive factors of engagement. It identifies links between a 'user's goals', 'memories', and 'judgements'. Furthermore, it suggests that poor usability and user experience leads to bad 'memories' and 'moods' which in turn impacts a user's 'judgement' of the product and their likelihood of future use.

Table 5.2 summarised the factors that were identified in each of the UE models. These factors help to explore an aspect of an individual's interaction with a DBCI, specifically their engagement. This builds upon the work in the previous section to create a more holistic representation of digital disengagement. The following section will explore the UX models to further develop the framework and its ability to understand longer term usage or disengagement.

5.3 User Experience (UX) Models

The field of UX is broad and wide-ranging. It includes numerous models, ranging from the more generalised to those addressing specific aspects or qualities of the interaction. It includes models like that of Thielsch *et al.* (2014), which explores the relationship between 'content', 'usability', and 'aesthetics', and Sutcliffe & Hart's (2017), which explores 'UX' and 'interactivity' more generally. It is therefore beyond the scope of this work to present all UX-related models. Instead, this section focuses on the general models of UX in order to identify the full range of factors relating to UX. This will guide disengagement research by providing the range of factors that may need to be explored within the DBCI context.

These models were identified through a series of Google Scholar searches which included the terms 'user experience' (or 'UX') AND 'model' AND 'technology'. The original search was limited to the six year period between 2010 and 2016. However, this search led to the identification of key researchers within this field, many of whom had published highly cited models that were subsequently included in this section. The chosen models have been selected because they bring a unique perspective of UX to this literature review. In addition, at least one of the authors from each model has been recognised as a key UX researcher (Bargas-Avila & Hornbæk, 2011, p.2691).

McCarthy & Wright's (2004a) 'Threads of Experience' (ToE) has been included because it theorises about how to think about 'an experience with technology'. In addition, it is widely cited and used within the field of HCI including by O'Brien & Toms (2008) to develop their 'Model of Engagement' (see Section 5.2.1).

Hassenzahl's (2005) 'Model of User Experience' (MoUE) interestingly presents components of UX from the perspective of both the designer and the user. This approach highlights the issue of differentiating between design intention and user experience. In addition, Hassenzahl & Tractinsky have written extensively within the field of UX, including the publication of a UX research agenda in 2006.

Thüring & Mahlke (2007) 'Components of User Experience' (CUE) Model identifies a number of key components that influence 'interaction characteristics' and the perceptions of product qualities. This model has been included because it is widely praised within the UX field; 'it constitutes the most-comprehensive model of UX' (Law *et al.*, 2014, p.529); '[t]he CUE model was a pioneer model in explaining the relationship between performance and affective part of a usability evaluation' (Chung & Sahari, 2015, p.169).

Finally, Hartmann *et al.*'s (2008) 'Model of the Users' Decision Making Process for User Interface (UI) Quality Assessment' (MoQA) explains the judgement process used by an individual during UX. Although the model title suggests that it concentrates on UI assessment, it has been used for general judgements of UX in later publications (see for

example, Sutcliffe (2009); Sutcliffe & Hart (2017)). The concept of user judgements appears in a number of different models and can provide insight for digital disengagement.

These models present the various interpretations of UX including factors that relate to the user, system, and context of use. They can also provide insight into why a user may digitally disengage from using a DBCI. This is the final selection of models to review for the disengagement framework.

5.3.1 Threads of Experience (ToE)

The 'Threads of Experience' (ToE) framework does not attempt to define the core elements of an experience but rather provides the language and approach to *think* about experience (McCarthy & Wright, 2004a, p.79-80). The framework consists of four threads of experience: 'sensual', 'emotional', 'compositional', and 'spatio-temporal'.

The 'sensual' thread focuses on the sensory aspects of an experience such as the touch and feel of the technology, the tone and sounds it makes, and the look of the object (McCarthy & Wright, 2004a, p.80). The 'emotional' thread – as the name suggests – refers to a user's emotions *but* not as stand-alone phenomena; emotions are a result of an individual in a specific situation and do not exist as independently formed entities (McCarthy & Wright, 2004a, p.83). The 'compositional' thread explores how the parts of an experience relate to each other and form the *whole* experience (McCarthy & Wright, 2004a, p.88). For example, this thread attempts to contextualise the experience, describe and understand it, and predict what might come next (McCarthy & Wright, 2004a, p.88). The 'spatio-temporal' thread refers to the space and time associated with an experience (McCarthy & Wright, 2004a, p.91). For example, an intense experience can affect an individual's perception of time and/or spatial awareness.

McCarthy & Wright (2004a, p.114) also consider the 'intrinsic' and 'extrinsic' meaning or value of an experience. The 'intrinsic meaning' refers to the value of the experience as an experience in its own right. On the other hand, the 'extrinsic meaning' refers to experiences that have a purpose; the outcome being more important than the journey towards it. This subtle difference in purpose can have dramatic effects on the design of a product. For example, a game – where the user is likely to be intrinsically motivated – will focus on making the experience fun, challenging, and rewarding. By contrast a spreadsheet application will be designed to make the task (calculations) as usable and efficient as possible to produce the desired result. It is likely that the terms 'intrinsic' and 'extrinsic' are not mutually exclusive. However, it is important to understand what type of interaction a DBCI user desires. This distinction between *usability* and *experience* relates back to the TAM research explored in the earlier section. Is it enough for technology to simply be usable and facilitate the desired outcome or is the user's *experience* just as important? The modern user has a multitude of other experiences,

notifications, and technologies to distract them so this consideration may increase in importance. This is clearly something that disengagement research relating to health-based DBCI needs to understand.

The 'Threads of Experience' (ToE) framework is not about breaking UX down into components but instead provides the categories through which disengagement should be considered. The different threads explore different aspects of an interaction and therefore disengagement factors could be identified in any or all of these categories. It is therefore important for disengagement researchers to consider the specific user, and their specific usage context.

This work does not identify specific disengagement factors but rather provides considerations for aspects of an interaction which could lead to disengagement. Furthermore, it highlights the issue of 'meaning' or value, which in turn feeds into expectations and motivation. What type of interaction is a user hoping to have with the DBCI? Are they intrinsically or extrinsically motivated? Furthermore, what role does the behaviour change process have within this? These are all significant considerations for disengagement research.

5.3.2 Model of User Experience (MoUE)

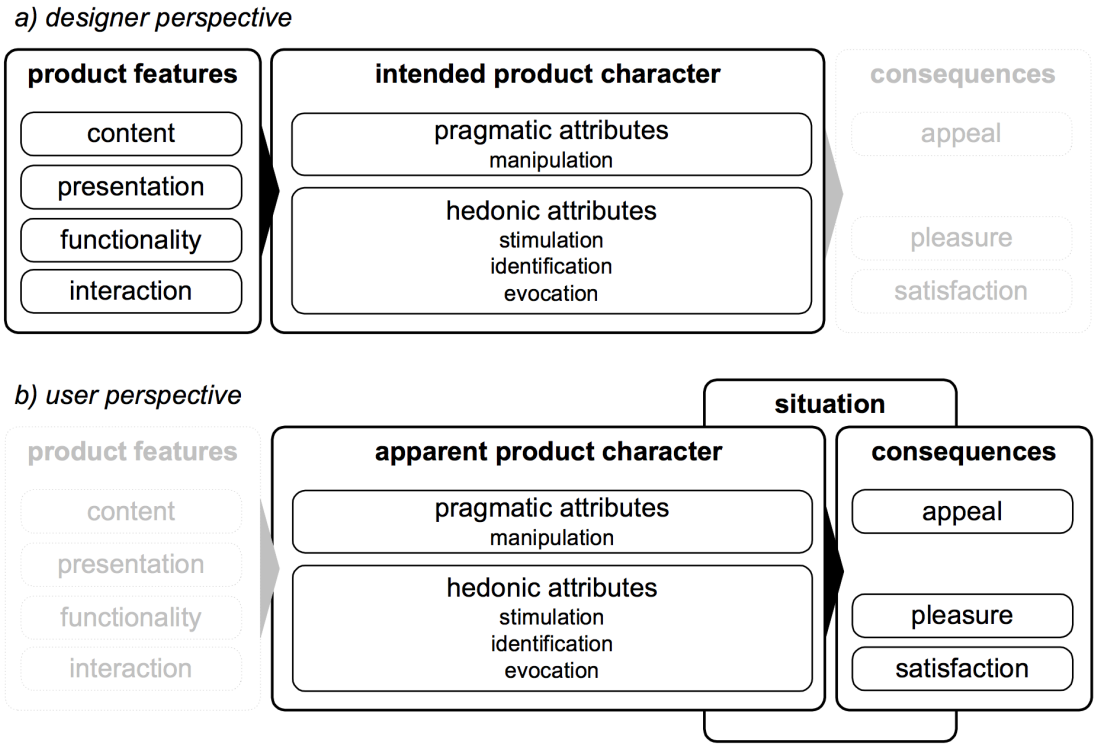

Figure 5.12: 'Model of User Experience' taken from Hassenzahl (2005, p.32)

Hassenzahl's (2005) 'Model of User Experience' (MoUE) interestingly differentiates between the designer's intention and the user's perception (see Figure 5.12). A designer uses product features – like 'content', 'presentation', 'functionality', and 'interaction' – to create the 'intended product character' – a high-level product description (Hassenzahl, 2005, p.32).

Product characteristics are separated into 'pragmatic' and 'hedonic' attributes. 'Pragmatic' attributes support the fulfilment of a behavioural goal by providing core functionality (i.e. utility) and easy access to that functionality (i.e. usability) (Hassenzahl, 2005, p.34). 'Hedonic' attributes address a user's 'psychological well-being' and aim to promote a pleasurable experience (Hassenzahl, 2005, p.35).

'Hedonic' factors are further subdivided into 'stimulation', 'identification', and 'evocation'. 'Stimulation' taps into an individual's desire for self-improvement or personal development – involving new skills or knowledge (Hassenzahl, 2005, p.35). 'Identification' addresses a user's desire for the product to communicate aspects of their identity, such as wealth or intelligence. 'Evocation' occurs when a product aims to trigger memories and this can be enough to create a desire for use (Hassenzahl, 2005, p.35-36).

The user's perspective indicates that a user will construct their perception of the product – 'apparent product character' – based on the 'product features' and their 'personal standards and expectations' (Hassenzahl, 2005, p.33). A user's 'personal standards' are formed by comparing this product to other products and technologies (Hassenzahl, 2005, p.33). A user's perception will also influence how they respond to the product (Hassenzahl, 2005, p.37) (see Figure 5.13).

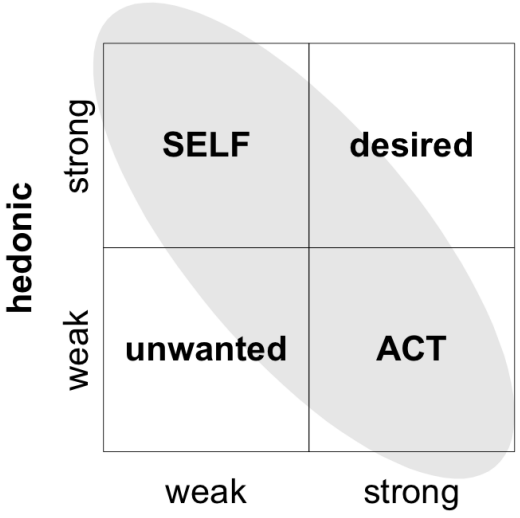

Figure 5.13: 'Product Characters Emerging from Specific Combinations of Pragmatic and Hedonic Attributes' taken from Hassenzahl (2005, p.37)

An 'ACT' product – strong pragmatic and weak hedonic attributes – helps a user achieve a specific behavioural goal and can become redundant if the user's goal changes or is achieved (Hassenzahl, 2005, p.37). In comparison, a 'SELF' product – weak pragmatic and strong hedonic attributes – appeals to the user's concept of self. This creates a more stable relationship between the user and product and leads to longer term use.

A product's attributes also aim to address a user's usage mode – 'goal' or 'action' (Hassenzahl, 2005, p.40). In 'goal' mode the user is aiming to complete a task, it is 'a means to an end'. On the other hand, in 'action' mode the use of a product can be an 'end in itself'. Both these modes relate to McCarthy & Wright's (2004b) intrinsic and extrinsic meaning. A product can be used in either mode and therefore the design should support both types of usage. Hassenzahl's approach (2005, p.40) is a more realistic conceptualisation of modern product usage over the more traditional 'work' or 'games' product groupings (for example, in Sutcliffe (2016, p.106)).

Finally this model also explains that any experience with technology generates a 'consequence'. This can be an emotional reaction – such as 'pleasure' or 'satisfaction' – and can therefore impact the product's 'appeal'. 'Appeal' is an evaluative judgement which considers perceptions of and experiences with a technology in a specific situation (Hassenzahl, 2005, p.38). Consequences of usage experience are understandably likely to influence future use.

This model explains the chain of events from the designer's intention, through the product features, to the user's perception of the product's character and whether this fits with the specific usage situation. There is a potential for disengagement at each stage of this process and therefore researchers need to understand each stage and its influencing factors. The 'apparent product character' emerges from the product's features – 'content', 'presentation', 'functionality', and 'interaction' – and therefore disengagement researchers should explore how a user is perceiving these. Furthermore, the product's appeal is temporal and therefore researchers need to consider the usage situation. It will also be important to understand whether DBCI users do alternate between usage modes and if so how to design for this.

This model cannot guide specific DBCI development as it outlines four product features but does not explain how to use these to generate a good UX because each experience is unique. This work also states that an 'ACT' product is likely to become redundant when the behavioural goal is achieved, suggesting that products should aim to appeal to the user's 'self' in some way. However, this issue may be less significant for a DBCI. If a user's behavioural goal is to facilitate their behaviour change, the achievement of this goal may make the DBCI unnecessary. This would suggest that DBCIs should be 'ACT' products – with strong pragmatic and weak hedonic attributes. However, the relationship between DBCI usage and the behaviour change process might be more

complex than this, requiring hedonic product attributes. DBCI designers need to better understand this relationship.

In conclusion, this research has provided a number of factors to explore for disengagement research and identifies the need for a better understanding of usage modes.

5.3.3 Components of User Experience (CUE) Model

Thüring & Mahlke (2007) present the 'Components of User Experience' (CUE) Model (see Figure 5.14). This model proposes three interlinking components of UX: 'perceived instrumental qualities', 'perceived non-instrumental qualities', and 'emotional reactions' (Thüring & Mahlke, 2007, p.263). 'Perceived instrumental qualities' relates to the controllability of the system and its ease of use. 'Perceived non-instrumental qualities' considers the look and feel of the system. These perceptions also impact the third element – the 'emotional reaction' – which results from the interaction.

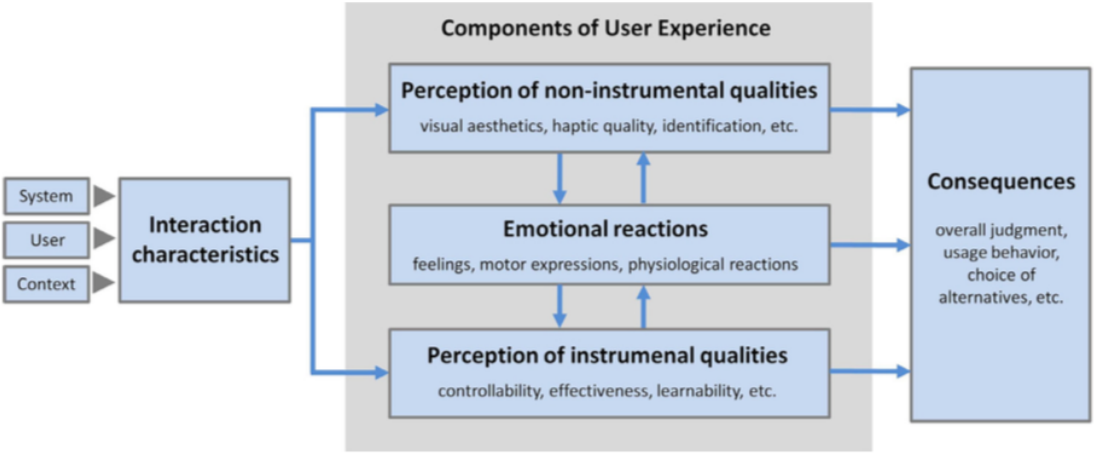

Figure 5.14: 'Components of User Experience (CUE) Model' by Thüring & Mahlke (2007) taken from Minge & Thüring (2018, p.14)

UX is the interaction between a user and technology. This interaction is affected by the 'task' and 'context' of use, 'user characteristics', and 'system properties' – the 'interaction characteristics' (Thüring & Mahlke, 2007, p.262). A user's perception of the product qualities and their emotional reaction to it is influenced by the interaction characteristics. A user's interaction with technology – the emotional reactions and perceptions of the product – feed into their 'appraisal of the system', including overall judgements, future use, and choice of alternatives.

User characteristics can include attributes – such as 'knowledge' or 'skill' – and system properties – such as 'functionality' and 'user interface'. However, these are just illustrative and the research paper does not provide further explanation. In a personal communication with Professor Thüring I was sent a document which provides further

explanation of these model components – such as the user's 'personality traits' or the 'safety and security characteristics' of the system (see Appendix B Table B.1). These have been included in the factors table (see Table 5.3). However, not all of these 'have been explicitly addressed in the CUE model' and the list 'does not claim to be exhaustive' (Personal Communications with Professor Thüring, 2016).

The additional explanations of model characteristics – from the personal communications with Professor Thüring – provide some additional explanations of the model. However, this model is very similar to Hassenzahl's (2005). The technology has system properties which are perceived by the user within a specific task context. These perceptions lead to future use and judgements of the system. A DBCI researcher certainly needs to consider these different variables when exploring a user's interpretation of the system.

5.3.4 Model of the Users' Decision Making Process for User Interface (UI) Quality Assessment (MoQA)

The 'Model of the Users' Decision Making Process for User Interface (UI) Quality Assessment' (MoQA) – originally published by Hartmann *et al.* (2008) and later published by Sutcliffe (2009, 2016) – explains the sequence of events that leads to a judgement (see Figure 5.15). The top section of the model shows the stages of decision-making and the bottom lists the influences on that process. Although the model's name implies that it explains the assessment of UI, it has also been described as explaining user judgement of UX and emphasises the iterative nature of this evaluative process (Sutcliffe, 2009, p.5).

An individual will use their 'usage goals', 'task domain', and 'background' to assess the suitability of an application or product (Hartmann *et al.*, 2008, p.15:23). They will be used to select and rank their decision-making criteria. This process is iterative as the user's experience with the technology will impact their opinions. As a result their 'dominant criteria' can change over time (Sutcliffe, 2009, p.5). However, the 'dominant criteria' will form the 'intention' or expectation against which the UX will be judged. This judgement results in either positive or negative 'attitudes' and 'memories' which feed back into the 'criteria'. Furthermore, the complex interaction between 'criteria', 'task' and 'user' influences their overall preference, which in turn leads to preferences of design, usage intention, and actual behaviour (Hartmann *et al.*, 2008, p.5).

The model proposes seven criteria for assessment: 'content', 'services', 'identity or brand', 'customisation', 'aesthetics', 'engagement', and 'usability'. Some of these are self-explanatory. However, 'services' refers to the application's functionality and 'identity or brand' addresses the application's reputation (Hartmann *et al.*, 2008, p.5). In later versions of the framework 'engagement' is replaced by 'interactivity' (Sutcliffe, 2016, p.107).

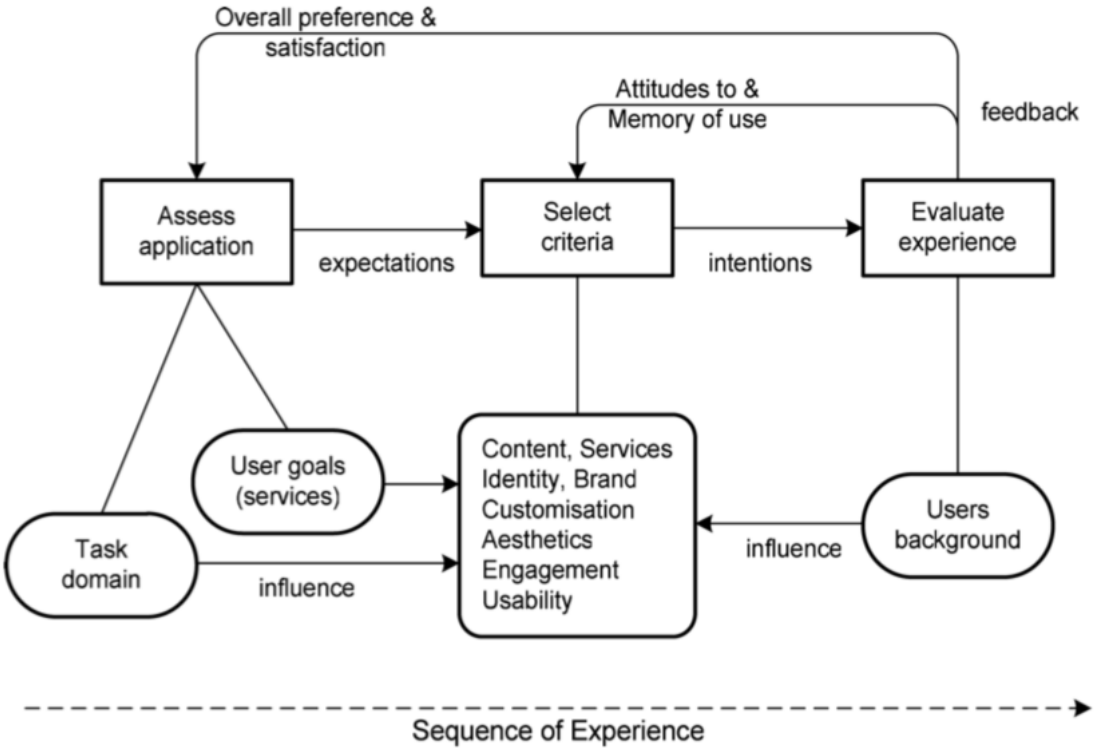

Figure 5.15: 'Model of the Users' Decision Making Process for User Interface (UI) Quality Assessment' (MoQA) taken from Hartmann *et al.* (2008, p.15-25)

This framework provides the various factors that affect the decision-making process, including the various criteria which an individual may judge the DBCI against. For example, a serious task will require an application with good usability and appropriate content, or a mobile application needs to be sensitive to screen size. Furthermore, these judgements directly link to preference and future use. This model should explain why a user selects one application over another.

However, MoQA was specifically included to understand the judgement process and therefore does not address the real-time usage of a DBCI. It therefore does not explain the disengagement factors once the user has selected one DBCI over another. The model also does not explain the different 'user background' factors which might affect this process and this limits its usefulness for identifying all the factors linked to this process.

In conclusion, the model provides an explanation of the judgement process which has been touched upon by a number of other models, including Hassenzahl (2005); Thüring & Mahlke (2007); and Sutcliffe (2016). Furthermore, it provides the criteria for this process, which if not met, might lead to disengagement and therefore should be considered for the framework.

5.3.5 Identified Factors

Table 5.3 presents the various disengagement factors from this UX research. These models specifically focus on the factors relating to longer-term usage of technology, beyond initial acceptance and adoption. However, the models explored in this section did not always use the same terminology to refer to a concept or factor. By collating these models into one table, similar factors were identified and listed under a single label in the 'Emergent Factors' column. When a publication has used a different term than the one listed, the tick has been bracketed, for example, see 'intervention - aesthetics' or 'competing apps & websites'.

Table 5.3: Summary table of UX models illustrating the overlap between digital disengagement factors

Emergent Factors	**1.ToE**	**2.MoUE**	**3.CUE**	**4.MoQA**
Ability			✓	
Competing Apps & Websites		(✓)	(✓)	
Demographics			(✓)	
Emotions	(✓)	(✓)	(✓)	
Intervention - Aesthetics	(✓)	(✓)	✓	✓
Intervention - Brand				✓
Intervention - Content		✓		✓
Intervention - Control		(✓)	(✓)	
Intervention - Effectiveness		(✓)	✓	✓
Intervention - Enjoyment	(✓)	(✓)		
Intervention - Expectations		✓	✓	✓
Intervention - Functionality	(✓)	✓	✓	✓
Intervention - Interactivity	(✓)	(✓)		(✓)
Intervention - Interest		(✓)		
Intervention - Judgement	(✓)	✓	✓	✓
Intervention - Novelty		✓		
Intervention - Perceptions	(✓)	(✓)	✓	(✓)
Intervention - Sensory	(✓)			
Intervention - Tailoring				(✓)
Intervention - Trust		(✓)	(✓)	
Intervention - Usability	(✓)	✓	✓	✓
Intervention - Usefulness	(✓)	✓	✓	(✓)
Intervention - Value	(✓)			
Knowledge		(✓)	✓	
Personality	(✓)		✓	
Psychosocial	(✓)		(✓)	

Continues on the next page ...

Emergent Factors	**1.ToE**	**2.MoUE**	**3.CUE**	**4.MoQA**
Self-identity	(✓)	(✓)	(✓)	
Skills		(✓)	✓	
Skills - Technical			(✓)	
Support - Intervention Design		✓		
Usage - Attention	(✓)	(✓)		
Usage - Awareness	(✓)			
Usage - Context	(✓)	(✓)	✓	
Usage - Efficiency		✓	✓	✓
Usage - Emotions	(✓)	✓	✓	
Usage - Engagement				✓
Usage - Experience	(✓)	(✓)		✓
Usage - Goals	(✓)	✓	(✓)	✓
Usage - Intention	(✓)	(✓)	(✓)	✓
Usage - Location	(✓)		(✓)	
Usage - Motivation		(✓)		
Usage - Past Experiences	✓	(✓)		✓
Usage - Satisfaction		✓	✓	✓
Usage - Time	(✓)	(✓)	(✓)	
User's Background				✓

The 'intervention - aesthetics' factor was referred to by the models in a variety of ways. For example, the 'Threads of Experience' (ToE) discusses the impact of aesthetics in two ways (McCarthy & Wright, 2004a, p.80). Firstly, they refer to the 'sensual thread' which explains the importance of 'sensory engagement' within an experience. This can include how an item or technology looks or feels. Secondly, McCarthy & Wright (2004a, p.86) explain that a user *judges* the value of an object on variables such as 'beauty'. Hassenzahl (2005, p.32) also refer to aesthetics in their 'Model of User Experience' (MoUE) but instead use the terms 'presentation' and the 'presentational style' of the product. The 'Components of User Experience' (CUE) Model describes it as the product's 'visual aesthetics' (Thüring & Mahlke, 2007, p.262). Finally, the 'Model of the Users' Decision Making Process for User Interface (UI) Quality Assessment' (MoQA) simply uses the term 'aesthetics', defined as the 'format in which the content and services are presented as well as the design look-and-feel of a system' (Hartmann *et al.*, 2008, p.5). Although using different terms, all of these models are referring in some way to what I have called the 'intervention - aesthetics' factor.

Another example of an emergent factor is the 'competing apps & websites'. The MoUE explains that individuals construct their perception of a product – the 'apparent product character' – based on their 'experiences', 'expectations', and 'personal standards'. These 'personal standards' are most commonly formed by comparing the DBCI to other

similar products (Hassenzahl, 2005, p.33). The CUE Model also discusses other apps or websites in the 'consequences' (or 'appraisal of the system') stage, referring to these as a 'choice of alternatives' (Thüring & Mahlke, 2007, p.262). These models are not just acknowledging the presence of other apps or websites but are illustrating the fact that these directly relate to how an individual will judge the DBCI. This competition between other products and the DBCI is represented in the 'competing apps & websites' emergent factor. This comparison between products was also found in the 'Model of Engagement' (MoE) research (see Section 5.2.1); O'Brien & Toms' (2008, p.950) participants returned to the application because 'it offered them something new (a product or an experience) that could not be obtained elsewhere'.

These examples illustrate the process of exploration and synthesis of the different model components (and their related descriptions) that led to the generation of Table 5.3. This also led to the identification of the various factors linked to UX and digital disengagement. Combining this table with the other tables from this chapter provides a holistic collection of digital disengagement factors for the framework.

5.3.6 Summary: UX Models

This section has reviewed a range of UX models from HCI literature. There was a significant amount of overlap between the model components, with the slight exception of McCarthy & Wright's (2004a) 'Threads of Experience'. McCarthy & Wright's (2004a) research aimed to present a framework to help understand the phenomenon of UX rather than offer a way to 'design for' or 'measure' it. However, it did highlight the importance of emotions and the spatio-temporal aspect of an experience. This is therefore a useful framework for understanding the different components of an experience.

These UX models have highlighted a number of important considerations for disengagement research. The user, the task, and context of use are often included as key components of UX; many of the models state that an experience or a user's perception of a product can change dramatically depending on these variables.

Hassenzahl (2005) explores the idea of moving beyond the instrumental or pragmatic requirements in order to encourage hedonic features. They state that a design must address the hedonic needs to create the strong relationship between user and technology, which is likely to lead to long-term usage. It is important to understand what type of 'usage mode' a DBCI user expects and requires.

This section has helped identify the factors relating to UX in order to better understand the barriers to long term engagement with a DBCI. These factors were grouped in Table 5.3 to help identify related and similar concepts to create a hybrid list of factors. The factors in this table further add to the previously identified digital disengagement factors from the previous sections.

5.4 Discussion and Summary: HCI Factors

Each section in this chapter has explored an aspect of the interaction between a user and technology. The technology acceptance models emphasise the importance of the user's perception, 'ease of use', 'usefulness', and the impact of 'experience' (i.e., usage over time). The UE models were fairly diverse in nature but provide a number of considerations for disengagement research, including the influence of time, motivation, and the environment. The UX models strongly support the move beyond the instrumental or pragmatic attributes to consider hedonic attributes and a focus on system features.

Several models explore the interaction between pragmatic qualities, hedonic qualities, and usage modes. McCarthy & Wright (2004b) explain the types of usage: either users interact for the experience itself (intrinsic) or for the outcome of the experience (extrinsic). Hassenzahl (2005) explains a similar concept using usage goals and Hartmann *et al.* (2008) represent this idea through the user's dynamic criteria selection. Hassenzahl (2005) explains that a product needs to cater for both types of usage, whereas Sutcliffe (2016, p.106) supports the more traditional 'games' vs. 'work' application. The difficulty for DBCI designers is deciding where DBCIs sit on this spectrum. This debate emphasises the importance of understanding a user's expectations and usage goals.

Motivation is a significant issue for behaviour change and if the task of using the DBCI feels tedious rather than fun, a user may not spend their time using the application. In addition, this type of application is competing against other (potentially more enjoyable) applications – such as games – and other life tasks. The question therefore becomes how 'fun' does this type of application need to be in order to encourage and entice a user into usage. By exploring the factors that lead to disengagement, researchers can start to answer this question.

Exploring all the HCI tables together (see Appendix B Table B.2) shows that there are multiple factors that bridge the different areas of HCI – such as 'intervention - usefulness', the role of 'emotions', and 'usage - intention'. Adoption models and UX models share a number of factors including 'competing apps & websites' and 'intervention - effectiveness'. This implies that a number of factors that influence initial acceptance also continue to have a role during long-term usage of a technology. There are also several factors that bridge UE and UX – such as 'intervention - interactivity' and 'intervention - aesthetics', supporting the relationship – presented by O'Brien & Toms (2008) – that *engagement* is a quality of UX. These areas of HCI therefore explore the different factors relating to a user's interactions with technology, and provide a holistic exploration of the experience.

The focus for a long time within DBCI research has been on psychological theories and content; this side of DBCI research is incredibly important. However, this chapter has also highlighted the importance of a good UX for user-technology interactions.

UX research is still rapidly evolving and there are new models being developed regularly. However, researchers acknowledge that context has a significant affect on UX and therefore it may not be possible to create a 'comprehensive' UX model. Incorporating these factors into a disengagement framework can provide DBCI designers with the tools to research non-usage of their health-specific DBCIs. The next chapter presents the disengagement framework, which has been created from this chapter and the previous Behaviour Change chapter.

Chapter 6

The DisENGAGE Framework: A Framework to Explore Disengagement from Health-Based Digital Behaviour Change Interventions

Chapter 4 and 5 reviewed models – from the fields of Behaviour Change and HCI – to identify behavioural and digital disengagement factors. These reviews produced several tables of factors – summary tables can be found in the Appendix A.5 and B.2 – which are the basis for the disengagement framework – RA2 – presented in this chapter.

The term 'framework' and 'model' are often used interchangeably and as a result it is not always clear how to define them (Nilsen, 2015, p.3). Nilsen (2015, p.2) explains that a 'model' is closely related to theory and explains – often in a simplified form – a phenomenon. On the other hand, a 'framework' provides an overview or descriptive categories that represent a phenomenon (Nilsen, 2015, p.2). Frameworks are not explanatory but rather provide a structure for the empirical data surrounding the phenomenon. Based on this definition, the following structure will be referred to as the DisENGAGE Framework because it provides the categories and factors of disengagement but does not aim to explain the phenomenon.

The following sections will present and explain the various aspects of the framework. This framework will provide the basis for the various case studies introduced and explored in the next few chapters.

6.1 The DisENGAGE Framework

The DisENGAGE (DisENgagement from health-based diGital behAviour chanGe intervEntions) Framework – see Figure 6.1 – has been constructed from the tables in Chapter 4 and 5. Figure 6.2 uses colour to highlight whether the factors were identified from the Behaviour Change literature, HCI literature, or both. The following sections explain the framework's categories and purpose.

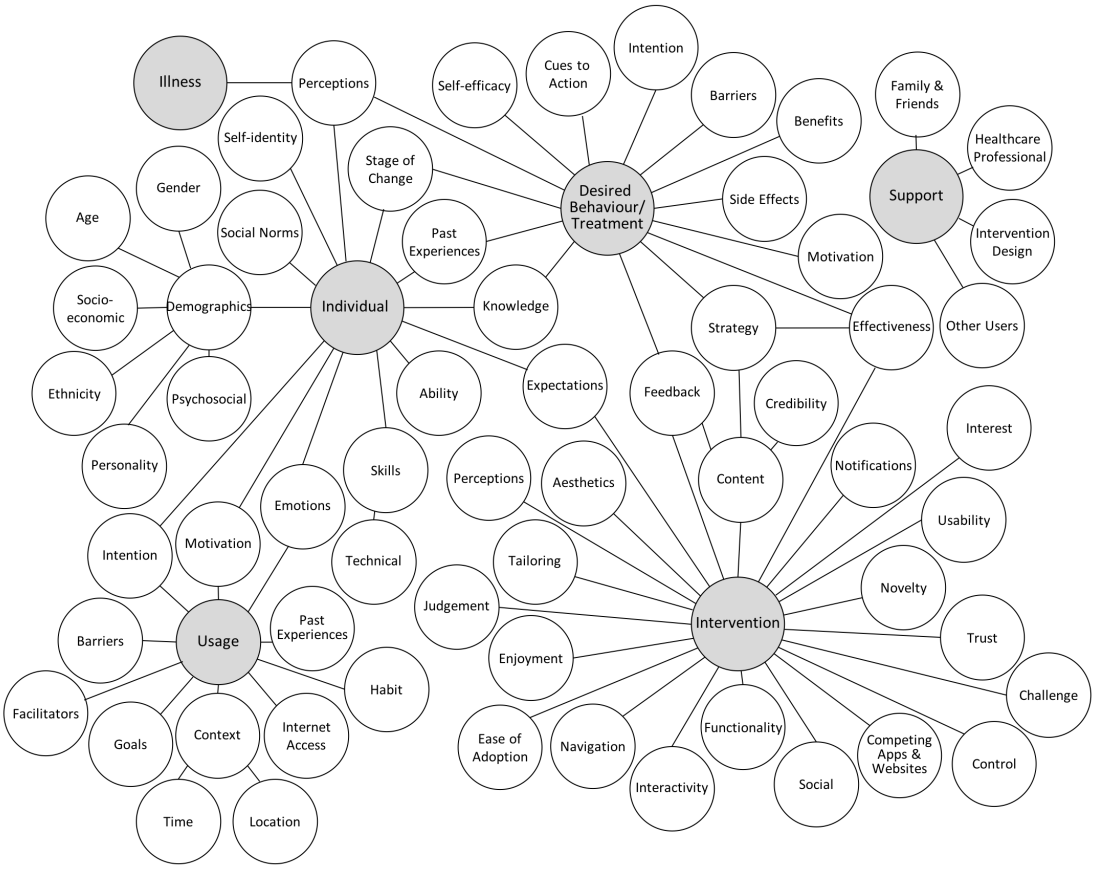

Figure 6.1: The DisENGAGE Framework

The framework contains connections between various factors. For example, the 'strategy' of the behaviour change attempt will be communicated through the 'content' and this will in turn impact the 'effectiveness' of the DBCI. The DisENGAGE Framework aims to guide researchers as they explore disengagement from an intervention; these links provide further indications of potential relationships that should be considered.

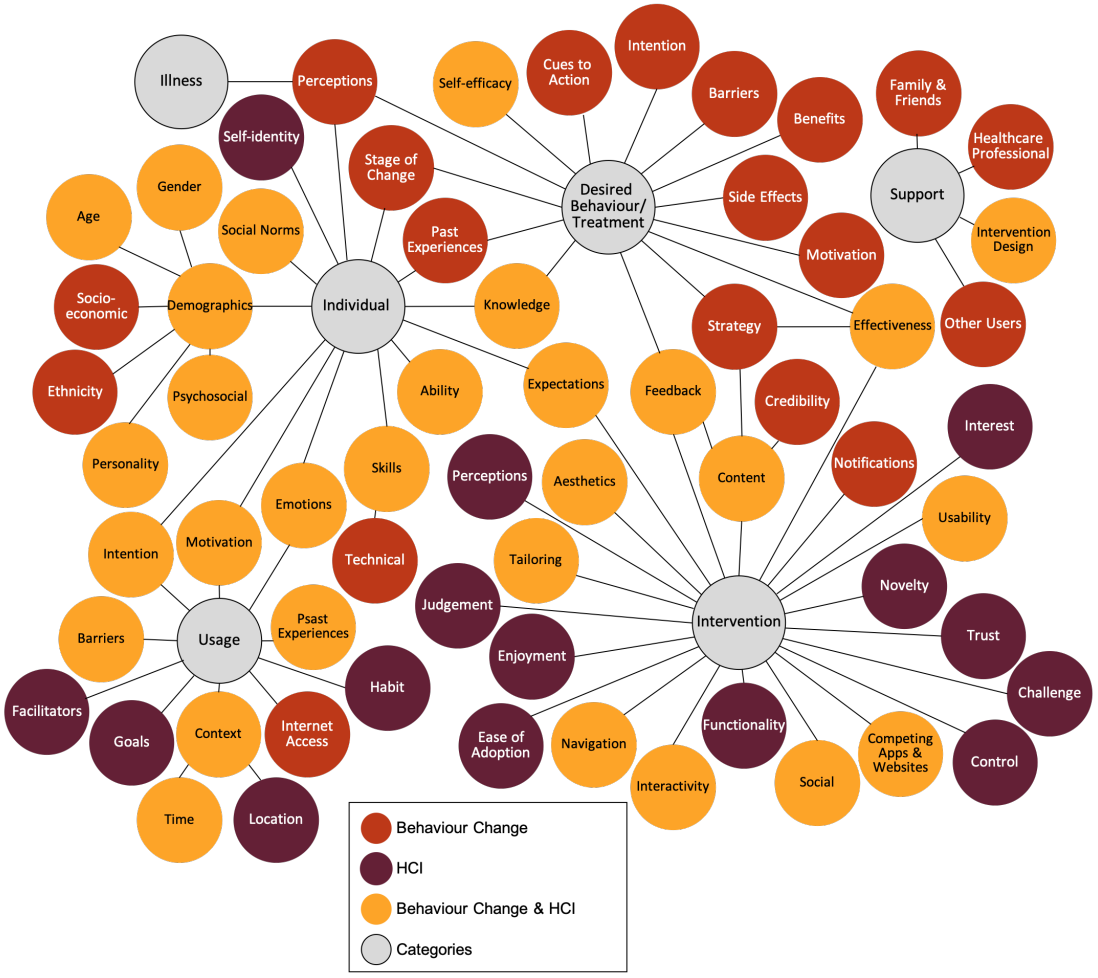

Figure 6.2: The DisENGAGE Framework (Coloured by Discipline)

6.2 Purpose

The DisENGAGE Framework supports a researcher or intervention designer during the entire research study. During the planning and design phase, the framework provides the factors – and relationships between factors – that a researcher may wish to explore. At the start of a research study, it is often difficult to identify all the relevant data collections points. However, if data is not collected for all interacting variables it can be hard to conduct informative process analyses or draw significant conclusions. The framework encourages researchers to plan their data collection to ensure the correct type and quantity of data is collected and help inform the selection of measures.

The framework can support the evolution of the analysis plan and guide the process of analyses. The framework helps plan data collection, ensuring all factors and interactions between factors are explored. Furthermore, if factors emerge from a different section of the framework, they can be referred to for further interactions and potential explanations.

A final application for this framework is for use by technologists who are interested in automatic data collection and logging. One of the attractions of DBCIs are their ability to automatically collect usage data – such as time and length of use, location and pages visited. As technology develops it may be possible to automatically collect additional types of data and this framework could provide the inspiration to focus such efforts within the DBCI community.

A framework of this kind will benefit from use and evolution. It has specifically been designed to adapt to the different types of DBCI, allowing researchers to select relevant aspects and modify the framework as required. It provides a tool to communicate across research disciplines to provide real progress and understanding around DBCI non-usage.

6.3 Categories

During the analysis of literature it became apparent that factors were appearing multiple times but relating to different aspects of the phenomenon. For example, 'motivation' appeared in both the Behaviour Change and HCI literature; the former referring to the motivation within the behaviour change process and the latter relating to usage of a technology. To minimise this ambiguity each relevant factor was categorised as either: 'behaviour/treatment', 'intervention', or 'usage'. This formed the basis for the framework categories: 'individual', 'desired behaviour/treatment', 'illness', 'intervention', 'usage', and 'support'.

There were a few factors which were not included in the framework because they were very similar to one of the other terms – such as 'fun' and 'enjoyment' – or they were not deemed to be relevant – such as 'brand' which is not applicable for an academic research context (see Appendix C Table C.1 for these factors and explanations).

6.3.1 Individual

Different models and research studies refer to the 'individual' using a variety of terms including: 'user', 'participant', 'individual' or 'client'. However, this framework uses the term 'individual' for a number of reasons. An individual has autonomy, reactions, and feelings and therefore plays an active role when using a DBCI. The term 'user' can suggest the individual is being passive in this process, simply using the product without making judgement or having opinions. 'Participants' potentially puts the focus on the study rather than the the individual and 'client' is not applicable in the academic research context. The term 'individual' also highlights the singularity of the person. Although they may have external support and influences, this term focuses on their unique attributes and characteristics.

Within disengagement research, the 'individual' is one of the most important considerations because it explores their personal experience with the DBCI, including their context and behaviour change attempt. For this reason, every other factor should be thought of in relation to that individual. For example, the individual's perception of the intervention content. Figure 6.3 shows the various factors that specifically relate to the individual. For example, it is important to consider an individual's characteristics and background to provide them with the most appropriate tailoring (Yardley *et al.*, 2015).

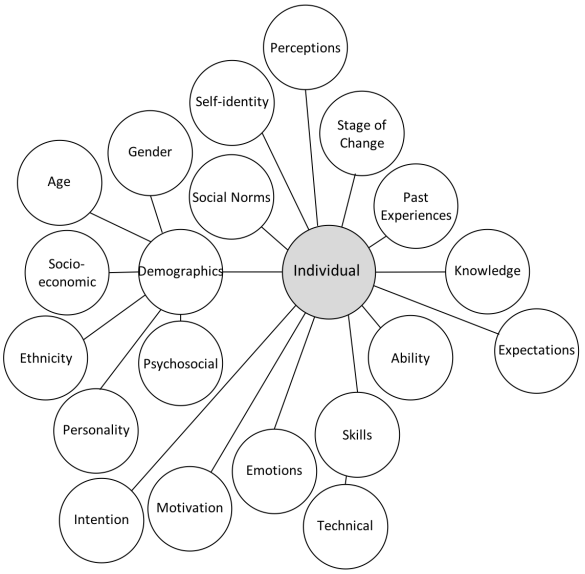

Figure 6.3: The DisENGAGE Framework: Individual

The individual's 'perception of' various factors was also emphasised by a number of the models; for example referring to 'perceived ease of adoption' or 'perceived enjoyment'. The DisENGAGE Framework does not prepend terms with 'perceived' because it would need to be added to all the terms on the framework because this type of research focuses on the individual's experience. Instead researchers should be aware that collecting disengagement data from an individual will be their perception and experience, but therefore researchers must collect detailed data about the individual and their context of use.

6.3.2 Desired Behaviour/Treatment and Illness

The factors in these categories – 'desired behaviour/treatment' and 'illness' – will depend upon the type of DBCI being researched. Some DBCI aim to help address an unhealthy *behaviour* – such as bingeing on alcohol or lack of exercise – whereas other interventions aim to help manage a pre-existing illness, which requires a *treatment* focus. Therefore the factors in these categories will not be applicable for every DBCI. However, Figure 6.4 shows the various factors that can encourage a desired behaviour or promote treatment adherence; the term 'desired' has been used to clarify the type of behaviour these factors are referring to.

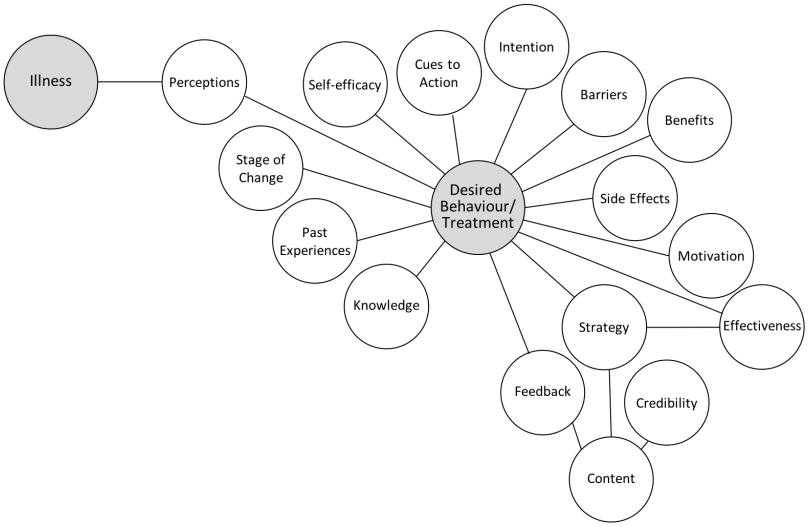

Figure 6.4: The DisENGAGE Framework: Desired Behaviour/Treatment and Illness

6.3.3 Intervention and Usage

The 'intervention' and 'usage' factors are closely related but have been separated to reflect the spatiotemporal nature of 'usage' factors. These factors influence whether an individual chooses to use the DBCI at that point in time. However, it is important to remember that these two categories affect one another. The 'intervention' factors relate to the design of the DBCI rather than the individual sessions of usage. For example, whether it is 'enjoyable' or the 'functionality' that it offers.

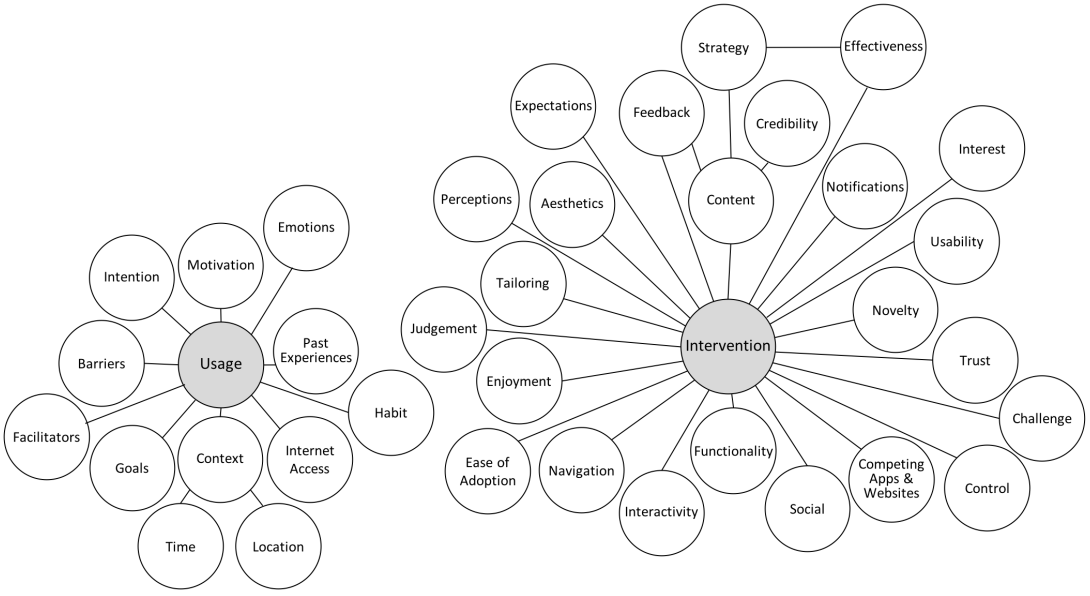

Figure 6.5: The DisENGAGE Framework: Intervention and Usage

6.3.4 Support

The issue of 'support' arose in relation to Behaviour Change and HCI literature. Rather than compartmentalising supportive people into their different behaviours, the framework presents them as people and technology – in the the case of the 'intervention design' – that can offer guidance and support. There is also an interesting relationship between the 'intervention design' and the 'healthcare professional' as in some cases the former may attempt to replace the latter; attempting to reduce the burden on the healthcare professional. This is an important consideration and needs to be carefully planned for, within the behaviour change strategy. It therefore may be important for researchers to understand how the individual is perceiving the support they are receiving.

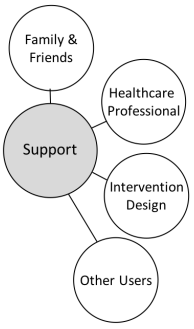

Figure 6.6: The DisENGAGE Framework: Support

6.4 Summary

This chapter has introduced the DisENGAGE (DisENgagement from diGital behAviour chanGe intervEntions) framework. This was constructed from the Behaviour Change and HCI literature explored in Chapter 4 and 5. The framework has six high-level categories: 'individual', 'desired behaviour/treatment', 'illness', 'intervention', 'usage', and 'support' and aims to support researchers and intervention designers in all phases of a study – including planning, data collection, analysis, and discussions. The next chapter presents the thesis methodology.

Chapter 7

Methodology

Chapter 6 presented the DisENGAGE Framework (RA2) generated from Behaviour Change and HCI models. The framework guides researchers through the planning, collection, and analysis of disengagement data. This chapter provides an overview of the methodological approach taken in this thesis, including how to utilise the DisENGAGE Framework to explore disengagement from a DBCI.

Section 7.1 explores the strength and limitations of the qualitative, quantitative, and mixed methods approach, specifically within the context of disengagement research. Section 7.2 introduces the three disengagement case studies which are analysed in the next few chapters. Section 7.3 introduces the LifeGuide software, used to create the three case study DBCIs. This section also explains how to analyse LifeGuide usage data to explore different aspects of disengagement. This approach to usage data analysis has been included in this chapter because it is used across all three case studies; case study specific methods have been included in the individual chapters.

7.1 Quantitative, Qualitative, or Mixed Methods

The DisENGAGE Framework highlights the multifaceted nature of disengagement. A user can disengage from the technology digitally, or from the behaviour change process behaviourally, or from both (digital-behavioural disengagement). Understanding this phenomenon in its entirety is therefore very challenging and potentially requires a range of data collection methods. There are three main approaches to data collection: quantitative, qualitative, and mixed methods. This section explores the utility of these within a disengagement setting to identify the best approach for understanding this phenomenon.

7.1.1 Quantitative Approach

Quantitative research broadly deals with numerical data and often follows a deductive approach; a hypothesis is developed – based on current domain knowledge – which is then empirically tested (Bryman, 2012, p.25). Many researchers of DBCI use this approach to explore the behavioural aspects of engagement, often utilising usage logs or Web analytics (Lalmas *et al.*, 2014).

Usage logs automatically record how a user has interacted with a system. The type and frequency of data collection depends on the specific intervention system. However, logs often record the date and time of a session, the pages viewed, and the time spent on each page. More advanced systems can also include the location of usage, using GPS data, and track whether usage was prompted by a system notification or email.

Usage log data can provide indications about digital disengagement. For example, page flow data can reveal a section of the website that the user has not visited. This may be due to disinterest in the content or the individual may not have seen the link. Short page view times show that the user has clicked through the pages quickly, possibly because they were lost in the system or potentially they were quickly navigating to the page they wanted. This type of data can therefore show patterns of usage, but it cannot explain or contextualise this usage. This decontextualisation of data occurs when research methods focus too specifically on certain aspects of a phenomenon (Denscombe, 2010, p.132). Quantitative approaches alone also do not provide the in-depth data required for understanding behavioural disengagement.

7.1.2 Qualitative Approach

Qualitative research utilises words rather than quantification and often follows an inductive approach (Bryman, 2012, p.36). The inductive approach generates theories from collected empirical data (Bryman, 2012, p.26). This approach utilises methods – such as interviews or questionnaires – that provide rich data about an individual's experience. Collecting in-depth data about an individual's behaviour change attempt can provide insights into their behavioural disengagement – such as their willingness and desire to change. In addition, it can provide data about an individual's motivations and personal experiences of DBCI usage which cannot be captured in the usage logs, including their feelings about usage. However, although qualitative data can contextualise usage and provide insights into their behavioural disengagement it cannot replace the usage data. It is unrealistic and counterproductive to ask individuals to recall details about their sessions – such as pages viewed and time spent – and therefore qualitative methods alone cannot provide the data for digital-behavioural disengagement.

Qualitative analysis is also sometimes criticised for its subjective nature because researchers can draw different conclusions from the same data, thereby reducing the validity of the findings (Denscombe, 2010, p.123). Furthermore, it is also criticised for its lack of objectivity as participants' responses can be influenced as a result of being part of a study. Researchers also have to be aware of the impact of their values and biases during analysis (Denscombe, 2010, p.133); a process referred to as reflexivity. Qualitative researchers can minimise these effects by carefully planning data collection and by accounting for these biases during analysis.

7.1.3 A Mixed Methods Approach

The mixed methods approach does not solely focus upon quantitative or qualitative data or methods. Instead researchers start with a research problem and then select methods that will produce the most useful data (Andrew & Halcomb, 2009, p.68). In addition, the mixed methods approach has a number of other defining attributes such as the use of qualitative and quantitative methods in the same research project, a clear plan of the sequence and priority of the different methods, and an explanation of the relationship between these different types of data (Denscombe, 2010, p.134).

As illustrated above, quantitative and qualitative approaches alone are not able to provide a complete picture of disengagement. However, a mixed methods approach can overcome the limitations of the individual approaches. Combining a number of methods across the qualitative and quantitative divide is referred to as 'between-methods triangulation' (Denzin, 1978, cited in Johnson *et al.*, 2007, p.114). This type of triangulation aims to collect as broad a range of data as possible, generating a more holistic and representative analysis of DBCI disengagement.

Triangulation requires a researcher to consider how the qualitative and quantitative methods are going to be combined and used; whether the methods are going to be given equal priority – or weighting – or whether one will be prioritised over another (Bryman, 2012, p.632). For example, one question is whether there will be a primary and a secondary data collection method. The two types of disengagement seem to broadly align with the two approaches: quantitative (providing insights into digital disengagement) and qualitative (the behavioural aspects of disengagement). Therefore in order to explore the phenomenon as accurately as possible, researchers should give equal weighting to these different approaches. However, researchers may choose to focus on one specific area of the DisENGAGE Framework which may require a weighted approach.

Researchers also need to decide whether methods will be used in 'parallel' or in 'sequence'. 'Parallel' data collection – using different approaches – occurs simultaneously. 'Sequencing' can occur in either a 'two-phase' or 'multi-phase' process (Denscombe,

2014, p.151). A 'two-phase' approach uses one method after the other, such as QUALITATIVE → QUANTITATIVE, whereas the 'multi-phase' sequence uses a number of consecutive methods, such as QUALITATIVE → QUANTITATIVE → QUALITATIVE and so on.

Sequencing can be particularly useful for disengagement researchers because it can address the limitations of either the qualitative or quantitative approaches. For example, deploying a two-phase sequence allows a researcher to analyse the individual's usage data (QUANTITATIVE) and then tailor questions according to their specific usage (QUALITATIVE). For example, using the usage analysis a researcher can ask why the user rapidly clicked through pages or why they did not click on a particular section. This sequencing would therefore account for the limitations of the usage data – decontextualisation of data – and provide a more holistic analysis of that individual's usage experience.

Disengagement researchers may also wish to follow a multi-phase approach. For example, a researcher may wish to gather data about the specific health-related behaviour before designing the intervention (QUALITATIVE) or collect initial reactions to the DBCI (QUALITATIVE), then collect usage data (QUANTITATIVE) which will be analysed to generate interview questions (QUALITATIVE). The choice of sequencing often depends upon the time and availability of resources.

The mixed methods approach is time-consuming and may require the researcher to acquire new skills (Denscombe, 2014, p.161). However, to understand disengagement more fully, researchers need to consider these different aspects and so the increased time involved, is well spent. Furthermore, DBCI development and research is often conducted in a multi-disciplinary team that may have expertise in these different methodological approaches, thereby reducing this burden. A limitation of multiple methods is that it can produce conflicting data; this can delay the project schedule as researchers may need additional time to analyse and explain these inconsistencies (Denscombe, 2014, p.161). Although this may be true and could cause issues for deadlines, in my opinion it is not a limitation of the research approach because it simply highlights the existence of inaccurate or misleading findings.

7.1.4 Summary

A mixed methods approach can provide a more holistic, in-depth exploration of the disengagement phenomenon. Quantitative methods – in the form of usage logs – provide data about an individual's usage of a DBCI, which may give insights into their digital disengagement. Qualitative methods produce in-depth data which can provide insights into their behaviour change experience – or behavioural disengagement – and furthermore contextualises the usage log data. Following a sequential process, researchers can

also use each data set to inform the next data collection method. For example, an analysis of usage data can identify the necessary questions for the qualitative data collection, which can lead to a better understanding of their usage.

7.2 Case Studies

> 'A case study is an empirical inquiry that investigates a contemporary phenomenon within its real life context, especially when the boundaries between phenomenon and context are not clearly evident' (Yin, 1994, cited in Woodside, 2010, p.1)

The case study approach is sometimes referred to as a 'naturalistic' design because it focuses on a phenomenon in its natural setting; as opposed to an 'experimental' design, which involves the manipulation of various variables (Crowe *et al.*, 2011). This natural setting is particularly important when a researcher wishes to understand a phenomenon that is believed to be affected by context (Yin, 2003, cited in Bowling, 2014, p.423). Models from both the Behaviour Change and the HCI literature highlighted the importance of *context* on both the behaviour change attempt and the factors of disengagement.

Crowe *et al.* (2011) also explain that case studies can help to answer the 'how', 'what', and 'why' questions of a phenomenon. This can help to understand the underlying causes of a phenomenon (Denscombe, 2014, p.57). This aligns with the aims of the DisENGAGE Framework, to better understand the underlying causes of disengagement from a DBCI.

This approach has been criticised for its lack of generalisability (Denscombe, 2014, p.61). Researchers need to consider how representative the case is or whether the findings are unique to the specific instance being researched (Denscombe, 2014, p.61). However, the use of this approach within this thesis has two objectives: to understand the disengagement factors from each specific DBCI, and to test the utility of the DisENGAGE Framework during a DBCI study. The first objective does not require generalisability because the set of disengagement factors will be unique to each case study. To address the second objective, this thesis explores three different types of DBCIs to ensure that the framework is useful across different DBCIs. This will show the usefulness of the framework in multiple behavioural contexts and usage settings. The lack of generalisability will therefore not hinder this work. Furthermore, this approach is also an established approach for testing theory.

The DisENGAGE Framework is based on theory, generated from models bridging Behaviour Change and HCI literature. Willig (2013, p.101) explains that the case study approach can be used to test, generate, or extend theory. A theory can be thought of as

a more advanced version of a framework; a framework only aims to provide an overview or description of a phenomenon (Nilsen, 2015, p.2), whereas a theory aims to explain a phenomenon (Michie *et al.*, 2014a, p.22). A case study is therefore an appropriate approach to test the DisENGAGE Framework empirically, in terms of its utility and role within the disengagement research process. Furthermore, this in-depth analysis identifies additional disengagement factors that did not emerge from the literature (which can then be incorporated into the framework). These case studies can therefore help to provide a better understanding of DBCI disengagement and demonstrate the utility of the DisENGAGE Framework.

Therefore, in addition to following a mixed methods approach, this thesis will also follow a case study approach. This will allow for an in-depth context-dependent analysis of disengagement. It also supports a holistic exploration of the phenomenon (Willig, 2013, p.101), which is particularly important when researchers need to understand the relationship between digital and behavioural disengagement. The different case studies allow the exploration of RA3 – investigating how qualitative and quantitative (usage) data can be used to understand disengagement using the framework. Case study 3 also addresses RA4 – demonstrating how the theoretical framework can guide researchers through the process of disengagement research, including planning for, collection of, and analysing disengagement data.

The following section introduces the LifeGuide software, which was used to create the DBCIs used in the three case studies. It also explains how LifeGuide usage data can be used in disengagement research. This approach to usage data analysis has been included in this chapter because it is used across all three case studies; case study specific methods have been included in the individual chapters.

7.3 LifeGuide and Usage Data

This section presents the LifeGuide[1] software, which was used to create the case study DBCIs and explains how the LifeGuide usage data can be analysed. LifeGuide interventions consist of an activity or information pages, which a user can navigate through. Each intervention has a logic file that specifies the order of the pages. It can also restrict access to certain pages or areas of the site depending upon whether a user has performed a specific action or activity. Interventions can also send participants notifications to prompt them to log in or ask them to complete an activity.

[1] `http://www.lifeguideonline.org`

7.3.1 Architecture

The LifeGuide software guides researchers and clinicians through the process of creating and deploying an intervention. It was specifically developed to support researchers – especially those without a computational background – with the development of tailored DBCIs (Hare *et al.*, 2009). The software suite consists of three components: a desktop authoring tool to design the intervention, a web-based interface to host and run the intervention, and a web-based viewer to explore and download the usage data (Hare *et al.*, 2009). It also offers an easy way to export usage data for analysis.

The authoring tool allows designers to create each intervention page using the drag-and-drop feature of the WYSIWYG[2] interface (Williams *et al.*, 2010b, p.14). The tool supports features such as interactive questions, navigational buttons, and audio or video content (Williams *et al.*, 2010a, p.2). Templates are provided to help standardise pages (Williams *et al.*, 2010b, p.39).

When an intervention is first created the authoring tool also generates a blank logic file (Williams *et al.*, 2010b, p.66). The logic file allows designers to set a series of page flows, which are dependent on certain logic statements. Intervention designers can also create a tunnel architecture which dictates the pathway through a site. This enables designers to tailor the content to individual users. Page flows and intervention architecture can become very complex (see Appendix D Figure D.1 for the PRIMIT (case study 1) architecture). The logic file also creates new user profiles, assigns participants to intervention groups, and can include scripts that send emails and SMS messages to participants (Williams *et al.*, 2010b, p.14). The logic code is written by the intervention designer but is aided by an auto-suggestion drop-down list in the authoring tool.

LifeGuide also allows developers to save user inputs. All data entered in an interactive feature is automatically saved at the end of a session. The software also automatically records session details – such as the time of a session, pages viewed, and time spent on each page. Researchers can manually save inputs in the user data that are critical to their research study.

7.3.2 Data Exports

LifeGuide data can either be downloaded as a .csv or .xls file, and includes four files: 'Page Duration', 'Page Flow', 'Session Details' and 'User Data'. Each line either represents a user or a session depending on the set export options. These options affect the 'Page Flow' and 'Page Duration' files as the 'per session' option includes anonymous users (unregistered users), which are removed from the 'per user' export. This also affects the 'Session Details' export which is explained below.

[2] WYSIWYG (What-You-See-Is-What-Your-Get)

The 'Session Details' file includes all data values input by the user during a session, such as free-text and multiple choice responses (LifeGuide Team, 2016, p.8). This data is automatically saved at the end of each session. The 'per user' option only exports the most recent value of each session variable, whereas the 'per session' exports all responses for that variable over the various sessions. This allows a researcher to analyse how that variable has changed over time.

It is important to note that if there is a server or connection issue during a user's session, but before the user closes session, then the entire session data can be lost. In comparison, 'User Data' is stored when a savevalue() command is triggered in the logic file and the user clicks a button on that page (LifeGuide Team, 2016, p.19). Intervention designers are therefore encouraged to manually save significant variables – that are required for the study – in the 'User Data' (LifeGuide Team, 2016, p.19). The variables stored in these files will be unique to each intervention and research objective.

The 'Page Flow' file allows researchers to see each user's session, including pages viewed and the time spent on each page (see Figure 7.1). Each row contains a 'user.identifier' (the name/email provided by the user during the sign up process), a 'user number' (unique ID number allocated by the system), the 'session number' (automatically counted), 'session start time', and then a continuous list of page names and durations (in seconds) for that specific session. When a page is visited a number of times the system adds a '#' followed by the number count. The 'Page Duration' file shows the total time spent on each page during each session (see Figure 7.2).

	A	B	C	D	E	F	G	H	I	J
1	user identifier	user number	session number	session start time						
2	telemed4	22733	1	26/01/2016 17:42	welcome	15	signup12	230	signup3	208
3	telemed21	22735	1	26/01/2016 18:20	welcome#1	4	signup12#1	43	welcome#2	0
4	telemed21	22735	2	26/01/2016 18:47	welcome	7	login#1	0	login#2	24
5	telemed4	22733	2	26/01/2016 18:49	welcome	7	login#1	0	login#2	21
6	telemed4	22733	3	26/01/2016 19:01	welcome	12	login#1	1	login#2	8
7	telemed4	22733	4	26/01/2016 19:16	welcome	7	login#1	0	login#2	54
8	telemed28	22743	1	27/01/2016 08:48	welcome	19	signup12#1	197	signup3	222
9	telemed28	22743	2	27/01/2016 09:08	welcome	45	login#1	0	login#2	43
10	telemed4	22733	5	27/01/2016 09:17	welcome	18	login#1	1	login#2	22
11	telemed27	22746	1	27/01/2016 09:45	welcome	8	login#1	0	login#2	27
12	telemed4	22733	6	27/01/2016 10:49	welcome	14	login#1	0	login#2	106
13	telemed4	22733	7	27/01/2016 11:02	welcome	20	login#1	0	login#2	4
14	telemed4	22733	8	27/01/2016 11:11	welcome	4	login#1	1	login#2	4
15	telemed15	22751	1	27/01/2016 11:13	welcome	9	signup12	135	signup3	92
16	telemed4	22733	9	27/01/2016 11:25	welcome	34	login#1	0	login#2	5
17	telemed24	22753	1	27/01/2016 11:26	welcome	89	signup12	134	signup3	83
18	telemed4	22733	10	27/01/2016 11:26	welcome	9	login#1	1	login#2	3
19	telemed4	22733	11	27/01/2016 11:40	welcome	4	login#1	0	login#2	4

Figure 7.1: An example screenshot of a 'Page Flow' LifeGuide export

	A	B	C	D	E	F	G	H	I	J
1	user identifier	user number	session number	session start time	welcome	login	loginneg	reset	resetneg	resetpos
2	telemed25	22920	2	14/02/2016 13:34	4	156	21	18		7
3	telemed14	22847	2	06/06/2016 20:57	9	106	13	18		660
4	telemed22	22764	2	04/02/2016 12:05	6	121	82	20		43
5	telemed7	22783	5	01/07/2016 14:35	6	256	13	22		10
6	telemed18	22882	4	21/02/2016 10:46	33	59		23		483
7	telemed6	22821	4	04/03/2016 15:22	9	136	21	23		232
8	telemed8	23223	2	01/06/2016 16:45	14	288	25	31		40
9	telemed42	23253	3	12/07/2016 21:23	20	482	126	44		35
10	telemed3	22833	9	15/02/2016 20:32	8	72	334	45		117
11	telemed16	22775	2	04/02/2016 16:53	20	146	76	83		521
12	telemed2	22804	96	03/07/2016 12:47	34	748	273	126		140
13	telemed16	22775	3	07/02/2016 17:17	33	630	1306	165		470
14	telemed16	22775	4	15/02/2016 17:14	9	1108	66	223		338
15	telemed4	22733	1	26/01/2016 17:42	15					
16	telemed21	22735	1	26/01/2016 18:20	4					
17	telemed21	22735	2	26/01/2016 18:47	7	54	21			
18	telemed4	22733	2	26/01/2016 18:49	7	21				
19	telemed4	22733	3	26/01/2016 19:01	12	9				

Figure 7.2: An example screenshot of a 'Page Duration' LifeGuide export

7.3.3 Limitations

LifeGuide is an easy to use, open-source software package that can be used by both programmers and non-programmers to create DBCIs. It supports tailored DBCI development and automatically logs sessional data which can be analysed to understand DBCI usage. However, the LifeGuide software has a few limitations.

LifeGuide records the date and time of every session, every page visited and the length of time spent on each page. The only exception is the time spent on the final page of each session. The time spent on a page is logged by the system when a user clicks a button to pass to the next page. This process does not occur on the final page of the session and therefore the system logs an 'unknown' value for this final page time.

LifeGuide also does not know how to log a tabbed page. A user will sometimes decide to open a link in a new tab rather than lose their location in the intervention. These pages tend not to get logged by the LifeGuide software.

However, LifeGuide is a good basis for these case studies because it produces similar usage logs to other intervention systems and supports conditional and tailored page flow.

7.3.4 Data Analysis

Once the data is exported from LifeGuide it needs to go through a number of processes and calculations to generate useful graphs for disengagement research. The following

sections explain these. Although these sections specifically use the LifeGuide exports, each stage of the analysis could be adapted for any usage logs.

This analysis utilises the programming language R[3], which specifically supports data manipulation, calculations, and graph generation. R scripts can be written and tailored to the needs of the researcher providing the flexibility that is not always available in other data processing software, such as Microsoft Excel. R scripts can also be written to work with multiple data sets, making them reusable.

7.3.4.1 Cleaning

Before analysing any data, it is necessary to clean it. R imports the csv file into a table (referred to as a data.frame) where each column belongs to a data class – such as 'numeric' (real numbers), 'integer' (whole numbers), or 'character' (normally a string of letters). The import automatically *classes* the columns. However, this process is not always 100% accurate and therefore the first step is to convert any incorrectly classed columns (De Jonge & van der Loo, 2013, p.18).

For example, Table 7.1 shows the class of each column for the imported page flow data. R has accurately classed all but one column. The 'session.start.time' has been classed as a 'character' column but is in fact a special date/time value – a 'POSIXct' object. This object type allows easy manipulation of the data, supporting date calculations and manipulation of format (De Jonge & van der Loo, 2013, p.20-21).

Table 7.1: Example page flow data imported into R

Columns	**Example**	**Class**	
		Automatic	**Correct**
user.identifier	telemed4	character	character
user.number	22733	integer	integer
session.number	1	integer	integer
session.start.time	26/01/2016 17:42	character	POSIXct
(various columns of) pages	welcome	character	character
(various columns of) times	15	integer	integer

Once the data is *technically* correct it needs to be checked for *consistency* (De Jonge & van der Loo, 2013, p.31). 'Consistent' data has no missing values, special values, or obvious inconsistencies and inconsistent data has to be addressed before any calculations can occur (De Jonge & van der Loo, 2013, p.31-37).

[3] https://www.r-project.org/about.html

There are a number of common LifeGuide specific inconsistencies. LifeGuide includes an 'unknown' value for the time spent on the final page (see Section 7.3.3). This 'unknown' value cannot be plotted on a graph so I have replaced it with a '1', the minimum amount of time a user would have spent on that page, whilst still acknowledging that this page was visited. LifeGuide also sometimes logs a page time of '0' when the logic file automatically redirects the user from one page to another. In this instance a user does not see that first page – only the page they are redirected to – and therefore the first page should be removed from the page flow data.

Certain LifeGuide export files also contain a number of empty columns. For example, the 'Page Duration' file (for each user) contains a column for every page in the intervention, regardless of whether that user has visited every page. R will fill these empty cells with an '*NA*' value, which stands for '*Not Available*' (De Jonge & van der Loo, 2013, p.10).

'Obvious' inconsistencies are defined as records that contain values or combinations of values that do not reflect the real-world situation (De Jonge & van der Loo, 2013, p.35). For example, an intervention may be designed so that the user can only view pages in a certain order; if a user has viewed these in a different order then this highlights an inconsistency which needs to be explored. Furthermore, intervention designers (and often members of the research team) will test the DBCI before deploying it to participants; these users are not part of the research study and therefore need to be removed from the data set before conducting the analysis.

Once the data has been cleaned and checked for consistency, it can be used to create graphs about the user's patterns of usage. The following sections explain the required process of data reshaping and the different graphs which can be generated.

7.3.4.2 Reshaping

Clean data may still require reshaping before it can be plotted. For example, data may still be in a 'messy' format (also referred to as 'wide') rather than a 'tidy' one (also referred to as 'long') (Wickham, 2014, p.4). Wickham explains (2014, p.4) that 'tidy' data fits the following criteria (and everything else is 'messy'):

1. Each variable forms a column
2. Each observation forms a row
3. Each type of observational unit forms a table

To successfully use many of the R packages, the LifeGuide data has to be reshaped. For example, the 'Page Flow' file contains messy data; it contains a series of repeated columns: 'page' and 'time' (see Table 7.2). These repeated columns should be stacked on top of one another creating one 'page' column and one 'time' column (see Table

7.3). This process can be achieved using the reshape()[4] function, which converts a table between wide and long formats. This type of reshaping is required for a number of the graphs discussed below.

Table 7.2: Example of messy (or wide) LifeGuide data

Session Start Time	**Page**	**Time**	**Page**	**Time**	**Page**	**Time**
26/01/2016 18:20	welcome#1	4	signup12#1	43	signup3	211
28/01/2016 18:47	welcome	7	login#2	24	*NA*	*NA*

Table 7.3: Example of tidy (or long) LifeGuide data

Session Start Time	**Page**	**Time**
26/01/2016 18:20	welcome#1	4
26/01/2016 18:20	signup12#1	43
26/01/2016 18:20	signup3	211
28/01/2016 18:47	welcome	7
28/01/2016 18:47	login#2	24
28/01/2016 18:47	*NA*	*NA*

The reshape() function utilises the following arguments: 'data', 'direction', 'varying', and 'v.names' (see Listing 7.1). Each user's session will contain a different number of viewed pages and times and therefore the ncol()[5] function is used to calculate the maximum number of columns for that particular user (line 1) – from that specific 'Page Flow' file.

Listing 7.1: Reshape code

```
1 colnum <- ncol(user)
2 user <- reshape(data = data.pageflow,
3                 direction = "long",
4                 varying = c(2:colnum),
5                 v.names = c("X", "Y"))
6 colnames(user)[which(names(user) == "X")] <- "page"
7 colnames(user)[which(names(user) == "Y")] <- "timesecs"
8 user <- na.omit(user)
9 user <- subset(user, durationsecs != 0)
```

In this example, the reshape() function takes the page flow data set (data.pageflow) (line 2) and converts it to a long format (direction) (line 3). To give the 'page' and 'time' columns context, the 'session.start.time' needs to be printed on each row (see Table 7.3), so the 'varying' columns – the columns which are to be stacked – start from column 2 (the first 'page' column) and continue to the maximum number of columns for

[4] https://www.rdocumentation.org/packages/stats/versions/3.4.3/topics/reshape
[5] https://www.rdocumentation.org/packages/hyperSpec/versions/0.98-20140523/topics/ncol

that user ('colnum') (line 4). Line 5 tells the reshape() function to create two columns ('X' and 'Y') and prevents the function stacking all the data into one column. Line 6 and 7 rename the column names to 'page' and 'timesecs'; line 8 removes any rows which contain *NA* values; and line 9 removes rows which have a page time of '0' (explained in Section 7.3.4.1).

7.3.4.3 Graphs

Usage data can be analysed in a number of different ways to answer a variety of different disengagement questions. The following sections present some of these different graphs, the data they require, and the process to generate them.

7.3.4.3.1 Login Graphs

As a starting point, it is helpful to understand how the entire population of users interacted with the intervention. This helps to identify which users have a lower rate – or no – usage, and highlights those that have digitally disengaged.

A login graph provides this overview by plotting each user on the y-axis against their login events (over time) on the x-axis. This graph highlights any frequent or infrequent users. It is a visual representation of attrition showing where participants' usage tails off over the course of a longitudinal study.

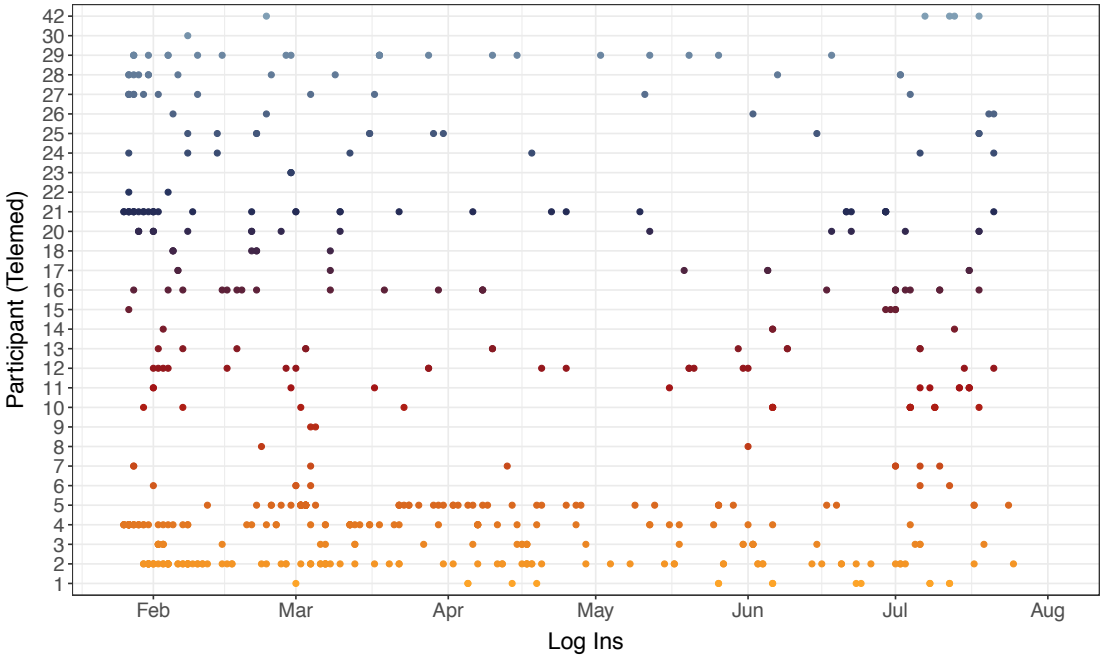

Figure 7.3: An example login graph from CIRCA (case study 2)

Listing 7.2: R code for the login graph

```
1  ggplot(data.session, aes(x = session.start.time,
2          y = factor(user.identifier), color = user.identifier)) +
3          geom_point() +
4          labs(x = "Log Ins", y = "Participant (Telemed)") +
5          scale_x_datetime(date_breaks = "1 month",
6                  labels = date_format("%b"),
7                  limits = as.Date(c('2016-01-25', '2016-08-02'))) +
8          scale_colour_manual(values = col) +
9          theme_bw() +
10         theme(legend.position = "none")
```

Every session in the LifeGuide database is time stamped and can therefore be plotted to show users' login patterns (see Figure 7.3). The ggplot2[6] library can plot each user along the y-axis (e.g. telemed4), each session along the x-axis (e.g. 26/01/2016 17:42), and assign a unique colour for each user (see Listing 7.2 line 1-2). Geom_point() tells the compiler to draw a 'point' at the provided (x,y) co-ordinates (see line 3). 'Labs' is short for labels and states the axes titles (see line 4). Scale_x_datetime formats the x-axis; the 'date_breaks' sets the number of vertical lines along the x-axis (see line 5); 'labels' specifies the format of these labels – in this case '%b' tells ggplot2 to use the abbreviated form of months (see line 6). Finally, 'limits' sets the date range on the x-axis; in this case the dates of the study (see line 7). The remaining lines (8-10) set colours and removes the legend. Colours are used in this graph to differentiate between users and make the graph easier to read.

7.3.4.3.2 Usage Over Time Graphs

After viewing the login graph and identifying particular users of interest, the usage over time graph can explain how much time a user spent on the intervention (see Figure 7.4). This type of graph can show if there is a significant change in usage over time, particularly highlighting phases of inactivity or activity. Furthermore, a particularly long or short session might indicate either a problem or an interesting session to explore further.

This graph plots the date of each session on the x-axis against the time (in minutes) on the y-axis. The x-axis can span across a day, week, month, or year, depending on the specific period the research wants to explore, or where the interesting activity is occurring. The default for this type of research is to plot the x-axis as either the time frame of the study or the timespan starting at the user's first session date and spanning through to their final session date.

[6] http://ggplot2.org

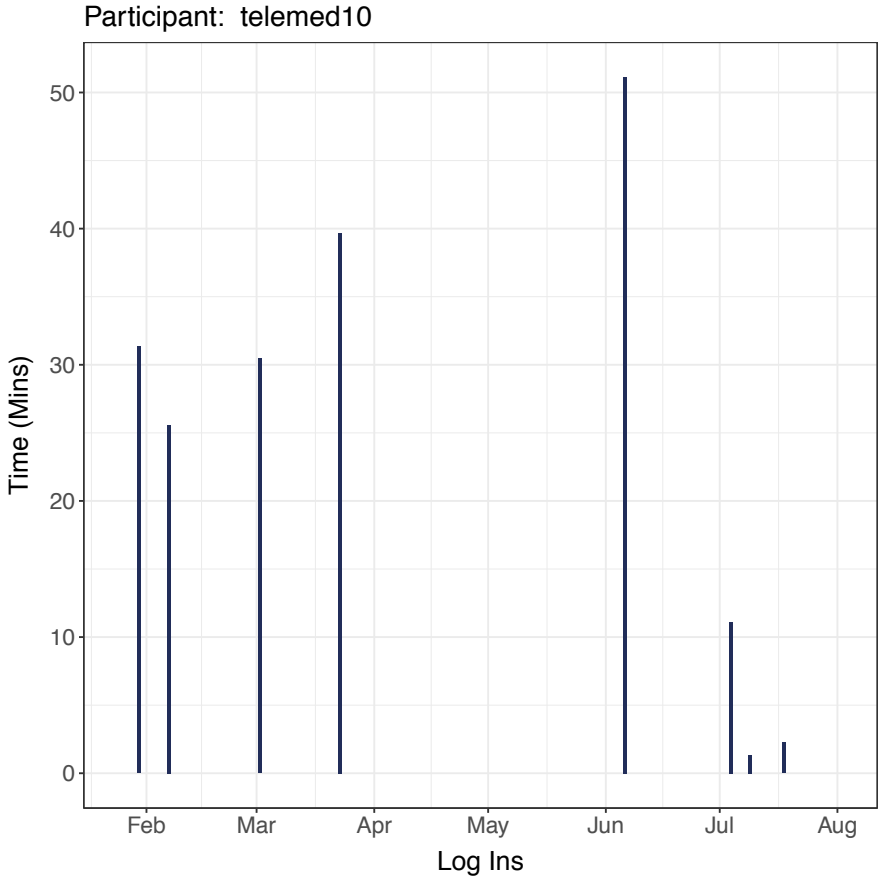

Figure 7.4: An example usage over time graph for a single user

To create this graph each data table must have a single user's page flow data – rather than the entire data set – and be reshaped() into a long format (see Section 7.3.4.2 for more details).

The x-axis uses the session time stamp (session.start.time) as the x value – in the same way as the login graph – (see Listing 7.3 line 1). The y value is calculated from the total time spent by the user in each session (i.e. the sum of all the page times for that session). The ggplot code can automatically stack each page time onto one bar provided the x-axis values are identical (e.g. 2016-02-02 20:25:00). Dividing the duration by 60 provides the time in minutes (see line 2). Line 3 tells ggplot to create a bar graph. Ggplot also has a built in count function, so the the 'stat = "identity"' code instructs ggplot to use the provided y values rather than using a count. The remaining arguments ('width' and 'fill') are aesthetic (column width and colour). Lines 4-6 set the x-axis parameters (explained in Section 7.3.4.3.1) and lines 8-14 are aesthetic.

Listing 7.3: R code for the usage over time graph

```
ggplot(data = user, aes(x = session.start.time,
        y = timesecs/60))+
        geom_bar(stat = "identity", width = 1, fill = "#212d59")+
        scale_x_date(date_breaks = "1 month",
                labels = date_format("%b"),
                limits = as.Date(c('2016-01-25', '2016-08-02'))) +
        labs(x = "Log Ins", y = "Time (Mins)") +
        ggtitle(paste("Participant: ", i)) +
        theme_bw() +
        theme(plot.title = element_text(size = 16),
                axis.text = element_text(size = 13),
                axis.title = element_text(size = 15),
                axis.title.x = element_text(margin = margin(t = 10)),
                axis.title.y = element_text(margin = margin(r = 10)))
```

7.3.4.3.3 Categorised Usage Graphs

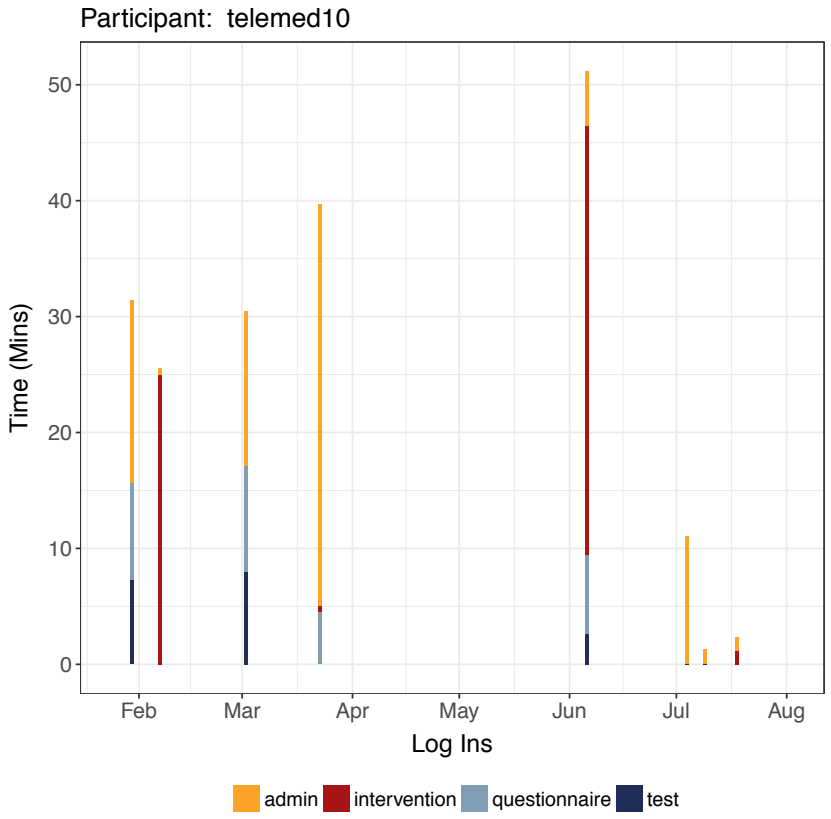

Figure 7.5: An example graph of categorised usage over time

This type of graph can either be presented along a timescale by login (see Figure 7.5) or by page category (see Figure 7.6). The timescale graph will highlight whether the type of page a user views changes over time. For example, a participant may spend longer on the admin pages (e.g., looking at the menu options) when they first start using the

intervention, but spend longer on intervention pages when they are more familiar with the navigation and content. However, if they spend all their time on the admin pages and are not accessing the intervention material it might indicate a problem to the researcher which they may want to explore further. This graph uses the same code as the previous section (Listing 7.3) but with a few changes to the aesthetics arguments to utilise the categorisation code explained below.

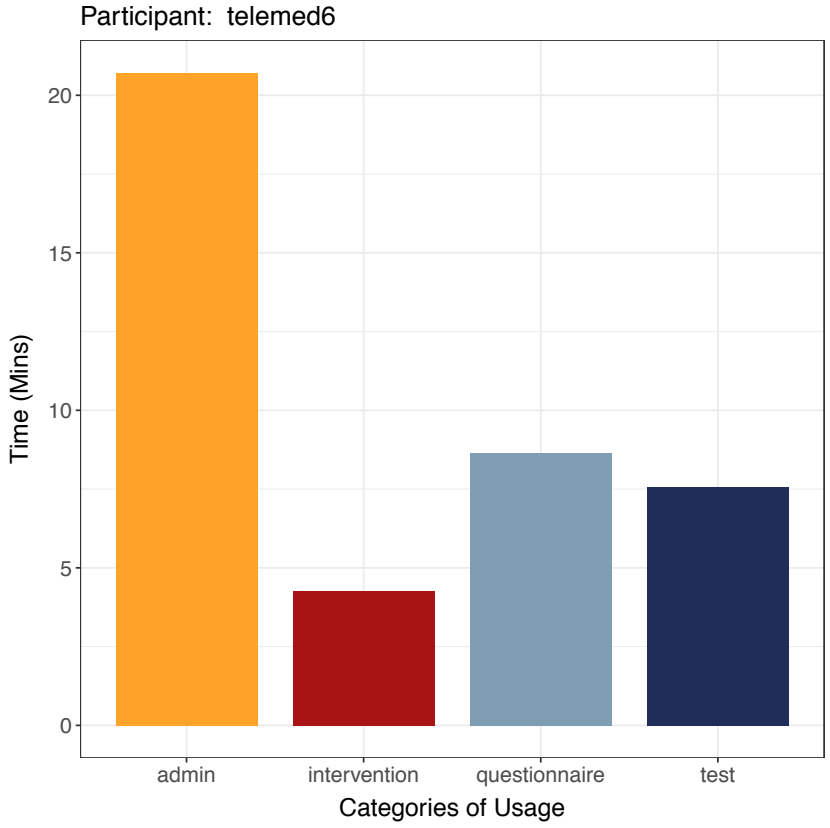

Figure 7.6: An example of a categorised usage graph

A categorised usage graph shows the total time spent in each section of the intervention – i.e., each category of pages (see Figure 7.6). This can highlight if a user spends a significant amount of time in one section or can show that a user has missed an area of the intervention entirely. A missed section might be of interest because it can highlight navigational issues; either indicating misleading or uninteresting menu options; or simply that the content did not appeal to the user.

This type of graph is constructed by grouping sets of pages into categories, the number of which will depend on the type of intervention and the required level of detail. To produce the categorised usage graph the page flow data has to first be converted to a long table format using the reshape() function (see Section 7.3.4.2). Data also needs to be cleaned.

LifeGuide appends a count to the page name, when a user visits the same page multiple times in one session, before adding it to the database. For example, when the user visits

the login page for the second time (in one session) it will be logged as 'login#2' rather than 'login'. This detail needs to be stripped away before calculations can be made.

Listing 7.4 (line 1-3) shows three types of categories 'adminPages', 'testPages', and 'questionnairePages', along with the pages of that intervention that fall under each category. These are intervention dependent and the provided example shows the significant sections of the CIRCA intervention (case study 2). In this example the 'if else' statement categorises each page as either 'admin', 'test', 'questionnaire', or 'intervention' (see line 4-8). The 'if else' statement works by comparing the 'data.pageflow$page' with the list of pages for each category. The intervention has four categories and therefore the code is written so that anything which doesn't fall into the first three categories – 'admin', 'test', or 'questionnaire' – will be a member of the forth – an 'intervention' page.

Listing 7.4: Mapping pages to categories

```
1  adminPages <- c("login|loginneg|signup|notworking|logout|exit|menu|
       welcome")
2  testPages <- c("start|test|results")
3  questionnairePages <- c("baselinequest|qres")
4  user$pageType <-
5          ifelse(grepl(adminPages, data.pageflow$page), "admin",
6          ifelse(grepl(testPages, data.pageflow$page), "test",
7          ifelse(grepl(questionnairePages, data.pageflow$page), "
       questionnaire",
8          "intervention")))
9  usage <- data.pageflow %>%
10         group_by(pageCategory) %>%
11         summarise(timeMins = sum(timesecs)/60)
12  ggplot(data = usage, aes(x = pageCategory, y = timeMins)) +
13     geom_bar(stat="identity", width= 0.8, aes(fill = pageCategory))
```

This coding requires knowledge of the intervention and how each page can be categorised. The script has to be tailored according to how the intervention designer has named the different pages. However, a standardised naming convention could reduce this workload in the future.

The dplyr[7] package (line 9-11) provides functionality to manipulate the data. The summarise() function specifically condenses down multiple items into a single summary. This code creates a new table called 'usage', with two columns 'pageCategory' and 'timeMins'. It takes the 'data.pageflow' data set (line 9), creates groups according to each category ('pageCategory'), and then adds up all the times in each group and saves this in the 'timeMins' column (line 11). The page categories ('pageCategory') are then plotted along the x-axis with time on the y-axis (line 12). Line 13 tells ggplot to build a bar graph using a different colour for each page category. There are some additional lines of code (which have not been included) that specify further aesthetic details.

[7] http://dplyr.tidyverse.org

7.3.4.3.4 Page Flow Graphs

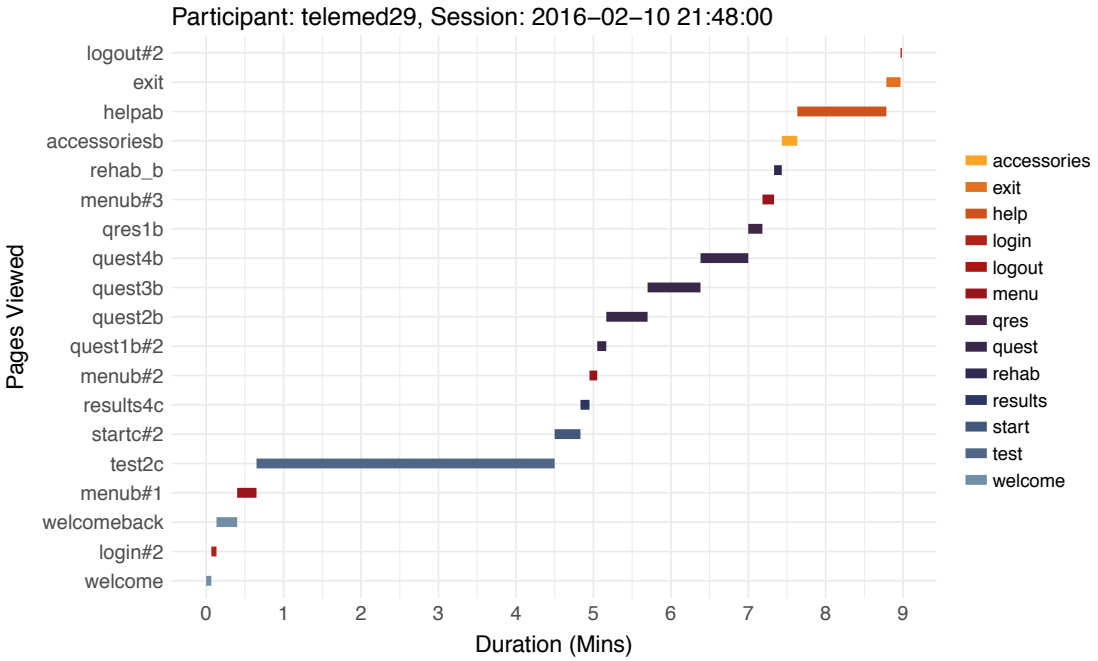

Figure 7.7: A basic page flow graph showing a single session

Page flow data can also be used to create a graph which shows the order and time spent on each of the viewed pages (see Figure 7.7). This type of graph provides a visual representation of each user's session and highlights various interesting elements of their interaction – such as the final page of their session. This could show a natural ending to the session – such as the final page of a section – or could show a user leaving mid-section or mid-questionnaire. If this appears to happen a number of times or across a number of users, it might indicate a problem with content, functionality, or the user experience. A user that is rapidly moving between pages might be lost in the system or unable to find what they are looking for (navigational issues). Alternatively this pattern of usage might signify that the user is not interested in the content of that section or it might help identify usability problems such as login issues (see Figure 7.8).

To produce a page flow graph, it is first necessary to take a subset of the data, selecting a single user and then a single session. Following this subsetting, the reshape() function (see Section 7.3.4.2) produces a data.frame similar to Table 7.4.

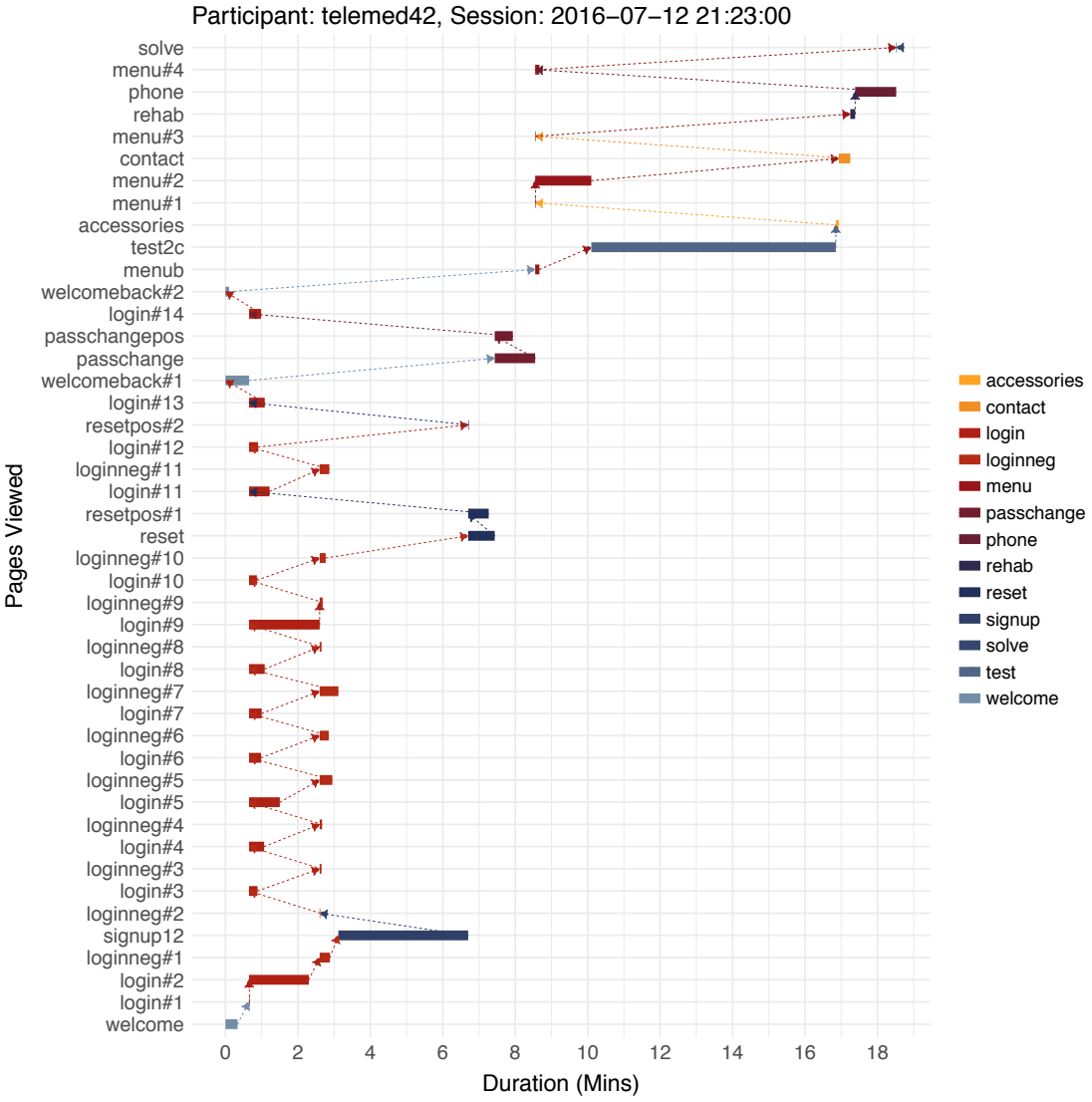

Figure 7.8: A page flow graph showing a single session, with arrows indicating the user's path through the DBCI

Table 7.4: Sample of page flow data

Session Start Time	Page	Time (Secs)
10/02/2016 21:48:00	welcome	4
10/02/2016 21:48:00	login#2	4
10/02/2016 21:48:00	welcomeback	16
10/02/2016 21:48:00	menub#1	15
10/02/2016 21:48:00	test2c	231
10/02/2016 21:48:00	startc#2	20
10/02/2016 21:48:00	results4c	7
10/02/2016 21:48:00	menub#2	6

The page flow graph is constructed using the geom_segment()[8] feature of the ggplot package. The geom_segment() draws a horizontal bar – of a specified thickness – between 2 sets of points (x, y) and (xend, yend) representing the time spent on a particular page (see Figure 7.9). These four points are calculated from the original page flow data.

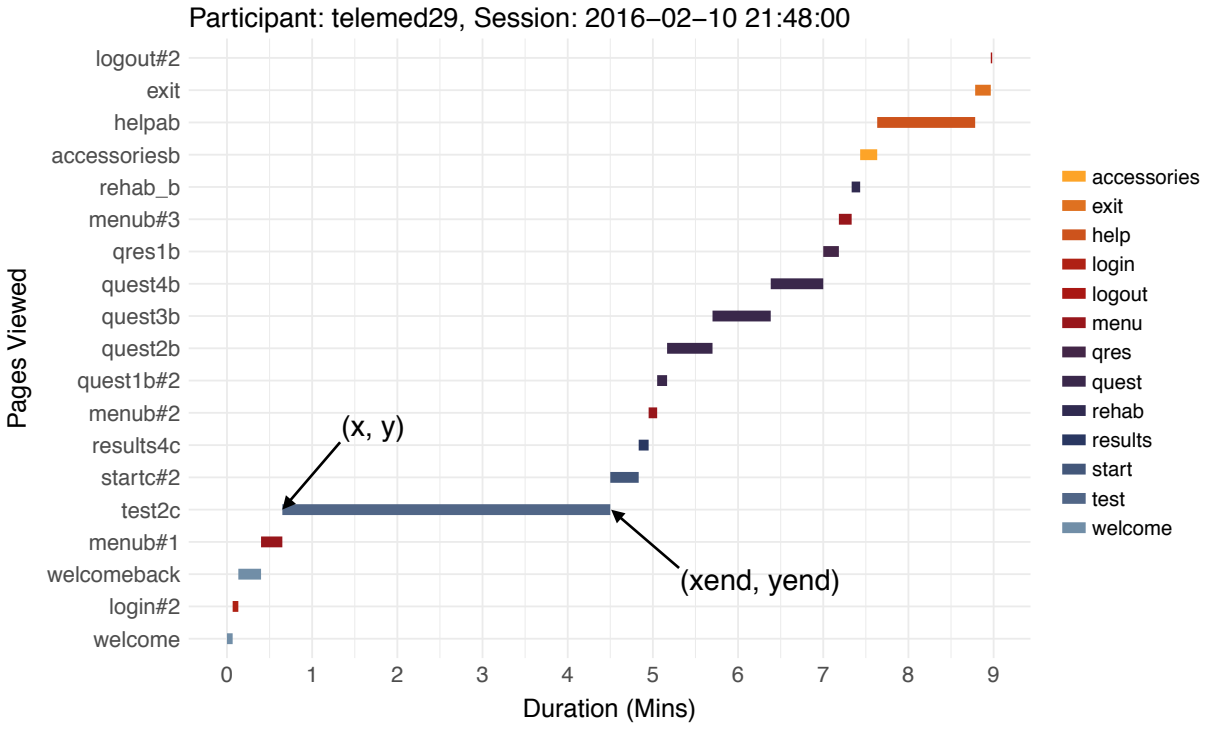

Figure 7.9: An annotated basic page flow graph that shows the x, y, xend, and yend points

The 'xend' point is calculated by cumulatively adding the time spent on each page (see Table 7.5). The 'x' point is calculated by subtracting the time spent on that specific page from the cumulative time – the 'xend' value. To calculate each y-axis point, the cumulative time value – 'xend' value – is added to the session start time. The bars lie on the horizontal axis and therefore the 'y' and 'yend' values are the same.

The graph can be adapted in a number of ways to make the identification of patterns easier. The x-axis can be used to align pages from the same section (see Figure 7.10) and arrows can provide guidance to the reader for how to interpret the graph (see Figure 7.11). This can highlight when a user has returned to the same section a number of times, indicating an issue with navigation. Colour is also used to make the graph easier to read.

[8] http://ggplot2.tidyverse.org/reference/geom_segment.html

Table 7.5: Example of page flow data

Page	**Time**	**xend**	**x**	**y & yend**
welcome	4	4	4-4= 0	21:48:00+0= 21:48:00
login#2	4	4+4= 8	8-4= 4	21:48:00+4= 21:48:04
welcomeback	16	16+8= 24	24-16= 8	21:48:00 + 8= 21:48:08
menub#1	15	24+15= 39	39-15= 24	21:48:00 + 24= 21:48:24
test2c	231	231+39= 270	270-231= 39	21:48:00 + 39= 21:48:39
startc#2	20	20+270= 290	290-20= 270	21:48:00+270= 21:52:30
results4c	7	7+290= 297	297-7= 290	21:48:00+290= 21:52:50
menub#2	6	6+297= 303	303-6= 297	21:48:00+297= 21:52:57

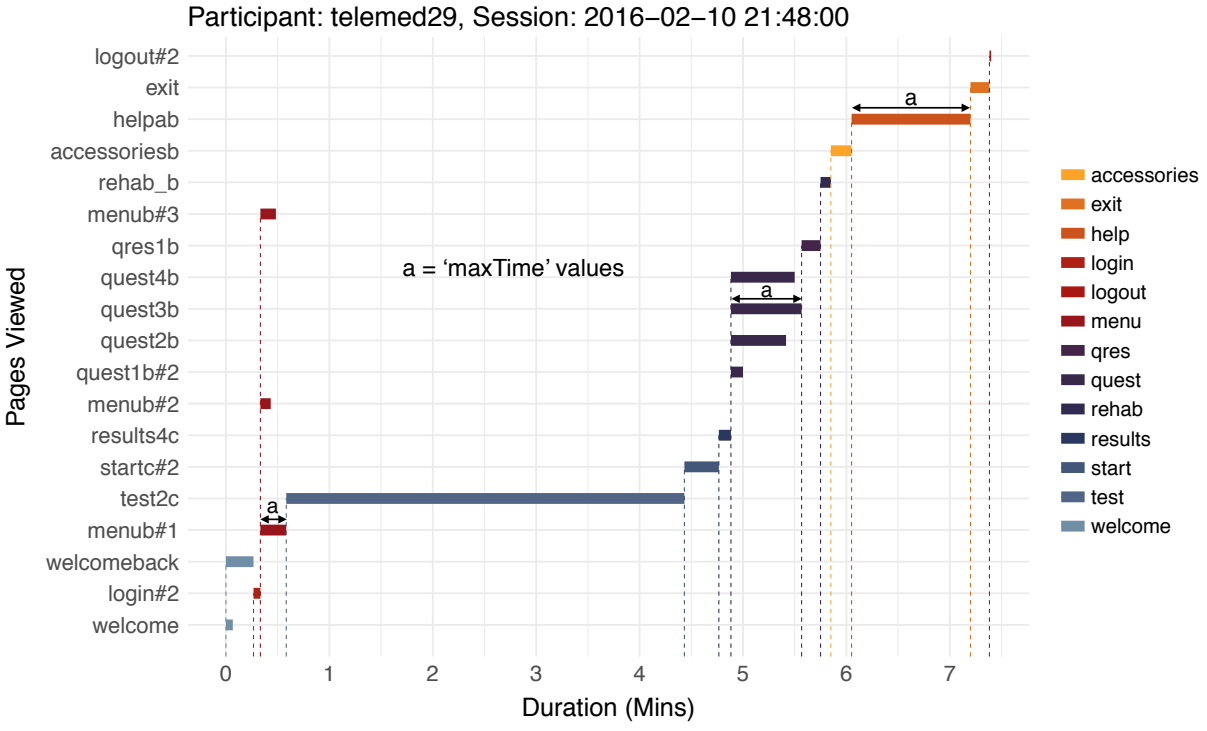

Figure 7.10: An example page flow graph aligned by page

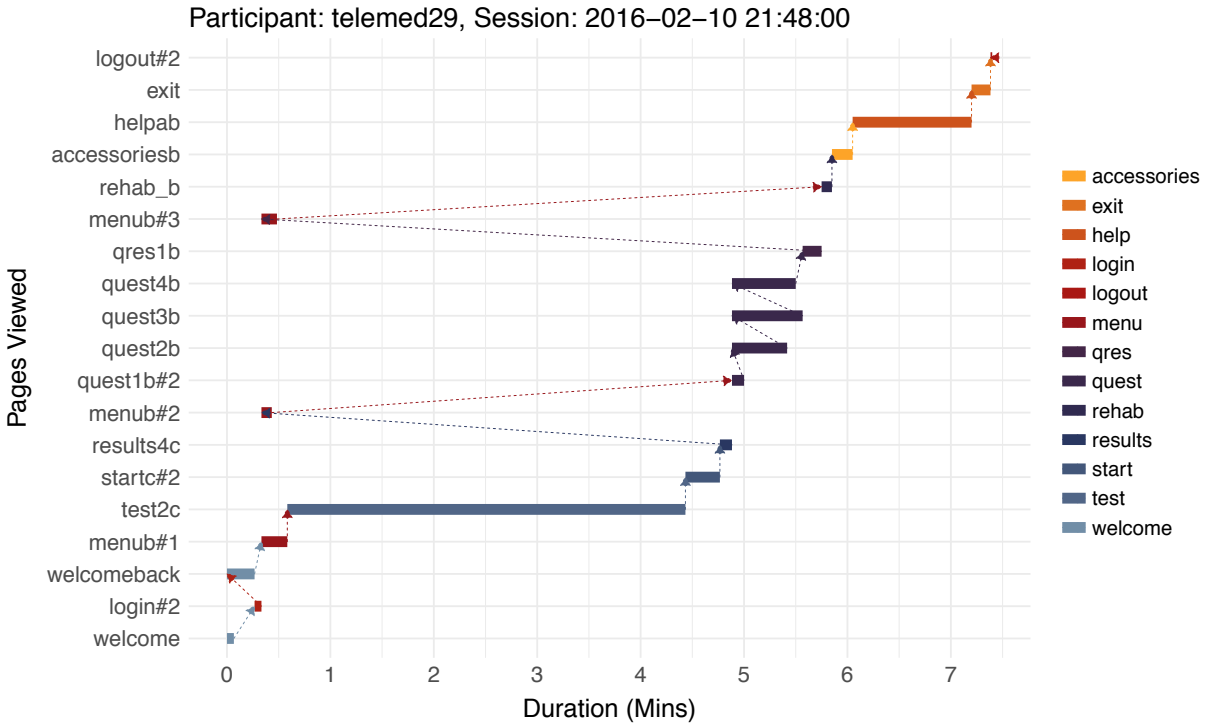

Figure 7.11: An example page flow graph with arrows highlighting a user's path through the system

Aligning pages viewed by their page type (see Figure 7.10) requires a set 'x' points for each page type. This calculation has to consider the maximum page time of all the viewed pages. This value is calculated using the group_by()[9] function. The group_by() function groups the pages by page type and then the summarise() function is used to condense down multiple items into a single summary; in this case using a max()[10] function. This iterates through every time recorded for that page (during that one session) to find the maximum time spent on that page ('maxTime').

Once the 'maxTime' value has been found it can be used to calculate the 'x' values for each page type (see Table 7.6). The 'maxTime' column is then cumulatively added to find the end point for each page type – the largest 'xend' for that page type ('cumulativeXend'). The 'x' value is then calculated by subtracting the maximum time for that page type ('maxTime') from the cumulative xend values ('cumulativeXend'). Each page type's max value ('maxTime') has to be calculated on a graph-by-graph basis because the maximum time spent on each page will change on a session-by-session basis. When the cumulative calculations are being made it is important that the pages remain in order of appearance.

[9] https://www.rdocumentation.org/packages/dplyr/versions/0.7.3/topics/group_by
[10] https://www.rdocumentation.org/packages/rapportools/versions/1.0/topics/max

Table 7.6: An example of the 'x' calculations for the aligned page flow graph

Page Type	**maxTime**	**cumulativeXend**	**x**
welcome	16	16	16-16= 0
login	4	4+16= 20	20-4= 16
menu	15	15+20= 35	35-15= 20
test	231	231+35= 266	266-231= 35
start	20	20+266= 286	286-20= 266
results	7	7+286= 293	293-7= 286
quest	41	41+293= 334	334-41= 293
qres	11	11+334= 345	345-11= 334
rehab	6	6+345= 351	351-6= 345
accessories	12	12+351= 363	363-12= 351
help	69	69+363= 432	432-69= 363
exit	11	11+432= 443	443-11= 432
logout	1	1+443= 444	444-1= 443

These calculations create a set 'x' values (starting points) for each page type and these values are then inserted into the page flow data table as the new 'x' values (see Table 7.7). The 'xend' for each individual page can then be calculated by adding the time spent on that specific page to the 'x' value for that page type. The 'y' & 'yend' are calculated in the same way as the basic page flow graph.

Table 7.7: A sample of aligned page flow data

Page	**Page Type**	**Time**	**x**	**xend**	**y & yend**
welcome	welcome	4	0	0+4= 4	21:48:00
login#2	login	4	16	16+4= 20	21:48:04
welcomeback	welcome	16	0	0+16= 16	21:48:08
menub#1	menu	15	20	20+15= 35	21:48:24
test2c	test	231	35	35+231= 266	21:48:39
startc#2	start	20	266	266+20= 286	21:52:30
results4c	results	7	286	286+7= 293	21:52:50
menub#2	menu	6	20	20+6= 26	21:52:57

The arrow annotations (see Figure 7.11) require a different set of (x, y) and (xend, yend) values which I will refer to as (xArrowStart, yArrowStart) and (xArrowEnd, yArrowEnd) to differentiate them from the horizontal bar co-ordinates. A number of the values from the aligned graph are used to calculate the arrow positions.

The arrow begins at the end of each bar – at the 'xend' point of each visited page. Therefore the 'xend' values can be directly written into the 'xArrowStart' column (see Table 7.8). Equally the 'yArrowStart' time is the same as the 'y' and 'yend' value for

each bar. The 'xArrowEnd' point is the 'x' point of the next visited page and therefore can be taken from the 'x' column of the horizontal bar data once the first 'x' value has been removed – shifting the x values up one row. R has a shift()[11] function which will shift all items in a column by a value of 'n'. This takes the 'x' values, removes the first item (n = 1) and fills the final row with *NA* (see Table 7.8). This shift() function can also be used to find the 'yArrowEnd' – where the arrow head is going to point to. The arrow head – 'yArrowEnd' point – should be the 'y' point of the next page visited so shifting the 'yArrowStart' values by 1 will create the new 'yArrowEnd' column.

Table 7.8: A sample of data used to calculate arrow co-ordinates

xArrowStart (aka xend)	**yArrowStart**	**x**	**xArrowEnd**	**yArrowEnd**
4	21:48:00	0	16	21:48:04
20	21:48:04	16	0	21:48:08
16	21:48:08	0	20	21:48:24
35	21:48:24	20	35	21:48:39
266	21:48:39	35	266	21:52:30
286	21:52:30	266	286	21:52:50
293	21:52:50	286	20	21:52:57
26	21:52:57	20	*NA*	21:53:03

7.3.5 Summary: LifeGuide and Usage Data

This section has introduced the LifeGuide software, which can be used by both programmers and non-programmers to create tailored DBCIs. These interventions save usage data which can be exported for analysis. Using R, this section has also explained the process of cleaning and reshaping data to produce usage graphs. These graphs can highlight patterns of behaviour, which can provide insights into digital disengagement.

7.4 Summary

This chapter has presented the methodological approach followed in this thesis. Quantitative and qualitative approaches offer insights into different aspects of disengagement. However, to explore this phenomenon holistically, disengagement research should follow a mixed methods approach as this can draw attention to different aspects of disengagement – usage data (digital) and qualitative data (behavioural). Furthermore, this chapter introduced and justified the complementary use of a case study approach to explore disengagement from various DBCIs and to test the utility of the DisENGAGE Framework. Finally this chapter introduced LifeGuide (the DBCI development software)

[11] https://www.rdocumentation.org/packages/data.table/versions/1.10.4-2/topics/shift

and explained the various ways of cleaning and analysing the usage data it generates. The next chapter presents the first case study – PRIMIT ('PRimary care trial of a website based Infection control intervention to Modify Influenza-like illness and respiratory tract infection Transmission').

Chapter 8

Case Study 1: PRIMIT and the DisENGAGE Framework

This chapter uses the DisENGAGE Framework to explore a large-scale DBCI data set called PRIMIT[1]. This analysis specifically uses LifeGuide usage logs (quantitative data) to develop a better understanding of disengagement from the PRIMIT DBCI. By doing so it addresses RA3 ('to investigate how qualitative and quantitative (usage) data can be used to understand disengagement using the framework'). It investigates the different ways of analysing usage data by focusing on two areas of the DisENGAGE Framework: the individual ('gender'), and the intervention ('perceptions', 'content', 'strategy', 'credibility', and 'trust').

Section 8.1 introduces the original PRIMIT research study, the study purpose and findings. Section 8.2 provides an overview of the PRIMIT intervention, its construction, and content. Section 8.3.1 explores how gender impacted the dropout rates between the four sessions. Gender has already been identified in the DisENGAGE Framework as a factor that may impact disengagement. Section 8.3.2 explores various user perceptions about the DBCI – including whether it gave all the advice needed, as well as its helpfulness, and trustworthiness – and whether the ratings of these were linked to the dropout rates.

This data set was not originally collected for disengagement analysis and therefore it is being used retrospectively. As a result, this type of analysis is limited by its retrospective nature and this is discussed in section 8.3.3.

8.1 The Original Study

The PRIMIT ('PRimary care trial of a website based Infection control intervention to Modify Influenza-like illness and respiratory tract infection Transmission') study was

[1] http://www.southampton.ac.uk/psychology/research/projects/primit.page

originally designed to investigate whether there was a relationship between frequency of hand washing and the number of respiratory tract infections (RTIs) contracted by an individual or members of their household (Little *et al.*, 2015). The PRIMIT intervention aimed to promote hand washing, which could then be used during a flu-epidemic (Little *et al.*, 2015, p.1631).

There are a number of publications about this study; the earlier publications present information about the design and initial pilot studies (see Yardley *et al.* (2011a), Yardley *et al.* (2011b)), whilst the later publications detail the full study (see Little *et al.* (2015)) as well as additional analysis of the data (see Ainsworth *et al.* (2017)).

Participants were recruited in England through their local GP practices and were selected if their household contained at least one other individual who was willing to report any illnesses during the study period (Little *et al.*, 2015). Participants were excluded if they were under 18 years old, suffered from severe mental health problems, were terminally ill, or a member of their household was already a study participant (Little *et al.*, 2015). Recruiters sent out 804,897 letters out of which 20,066 participants signed up and consented.

Originally the study was set up with two conditions: the intervention group and control group. However, all of these participants were asked to complete a baseline questionnaire which may have influenced their behaviour. As a result, two additional conditions were set up: the intervention group (with no baseline questionnaire) and the control group (with no baseline questionnaire). The study took place over three consecutive winters between 2011-2013 (Little *et al.*, 2015).

Participants were asked to complete a series of questionnaires at 4, 8, 12, and 16 weeks. The questionnaires covered a range of questions, including basic demographic details (such as age, gender, etc.), questions relating to their frequency of hand washing, the number of individuals in their household, and the frequency of RTIs in the past year (individually and in the household). An 'RTIs illness' – for this study – was defined as lasting more than one day and included two or more of the following symptoms: 'a high temperature (feeling very hot or very cold; or measured temperature >37.5°C), a respiratory symptom (sore throat, cough, or runny nose), or a systemic symptom (headache, severe fatigue, severe muscle aches, or severe malaise)' (Little *et al.*, 2015, p.1633).

The follow-up questionnaire also contained a number of additional questions including some relating specifically to the intervention. Participants were asked to rate the following statements on a scale of 1 (strongly disagree) to 7 (strongly agree):

1. The website gave me all the advice I needed
2. The website was helpful to me
3. I felt I could trust the website

The study found a reduction in both frequency and severity of RTIs for intervention users and members of their household Little *et al.* (2015, p.1636). However, episodes of RTIs were self-reported so further research was required.

8.2 The Intervention

Figure 8.1: PRIMIT 'Welcome' page

The PRIMIT intervention (see Figure 8.1) was developed following the PRECEDE-PROCEED model (Yardley *et al.*, 2011b, p.355). The researchers identified the behaviours most likely to influence the clinical outcome and tested their acceptability and feasibility with the target population using a focus group (Yardley *et al.*, 2011b, p.355). The 'Theory of Planned Behaviour' (TPB) then helped the researchers identify the appropriate mechanisms of action for the identified behaviours (Yardley *et al.*, 2011b, p.355). The DBCI prototype was then tested over various think-aloud sessions (Yardley *et al.*, 2011b, p.355).

The DBCI consisted of four weekly sessions that had to be completed chronologically. So if a user failed to complete session 3 they would not have access to session 4. Figure 8.2 highlights the aspects of PRIMIT's design and how they relate to the DisENGAGE Framework factors.

Session 1 provided information (content, knowledge) about the medical team (healthcare professional, credibility), the virus, and handwashing; questions (interactivity) about current habits (past experiences); and a personalised feedback (tailored, feedback) as a printable plan (strategy, cues to action, intention). Session 2 provided personalised feedback (tailored, feedback) based on their perceived barriers and benefits (perceptions, benefits, barriers). It also included further information about handwashing and the

virus (knowledge, content) and a quiz (interactivity) of flu facts. Sessions 3 and 4 had additional information and quizzes but Session 4 also reinforced hand washing as a social norm (social norm) (see Appendix D Table D.1 for full details about each session).

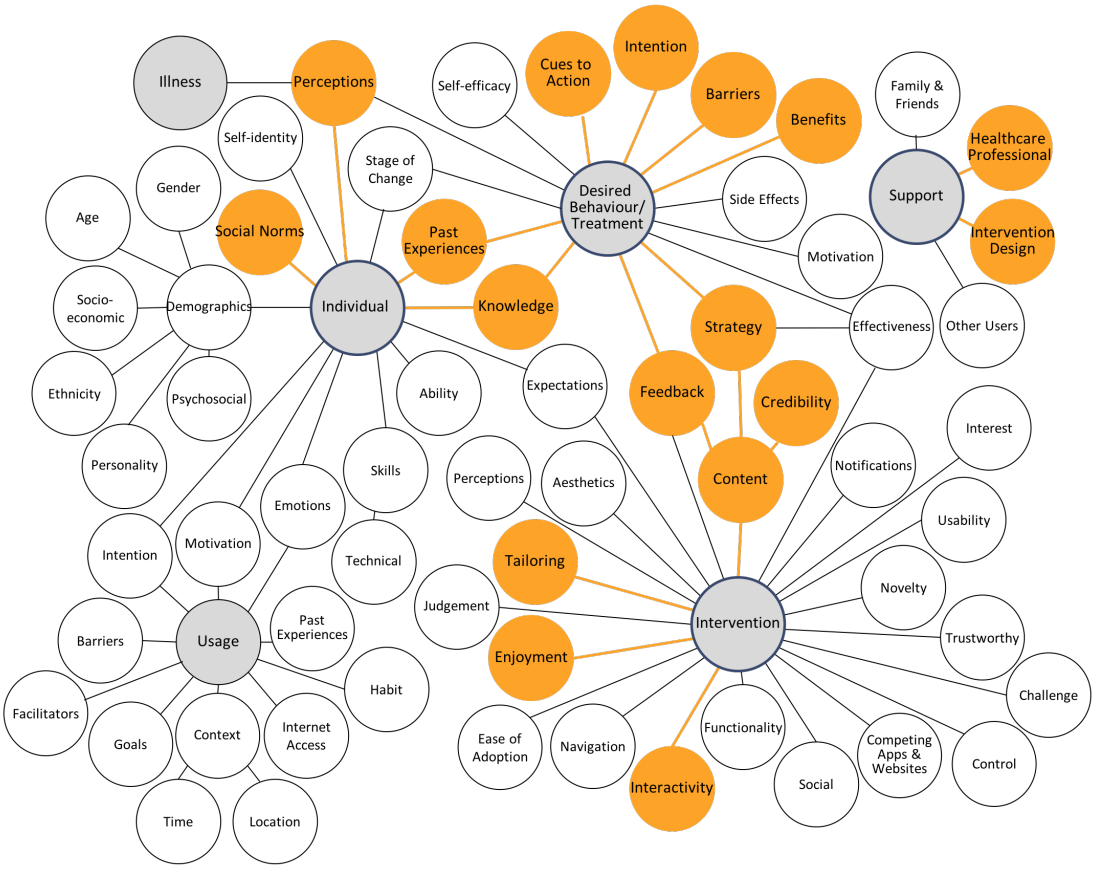

Figure 8.2: DisENGAGE Framework factors linked to aspects of PRIMIT's design

8.3 The Disengagement Analysis

This case study utilises the 2011-2012 PRIMIT data set which contains 19,501 participants. In addition to the questionnaire data, all sessions carried out by the users were logged in the LifeGuide database (see Section 7.3). The usage log recorded either a '1' (complete) or a '0' (incomplete) per session depending on whether the participant completed the entire module.

This data set was downloaded and cleaned by the original study researchers and therefore was not presented in the normal LifeGuide file exports, instead provided in a CSV and SPSS file format. Once this data was imported into R it was cleaned and reshaped following the stages explained in Section 7.3.4. Missing values were replaced with '*NA*', which stands for '*Not Available*' and will be used for the remainder of this chapter.

As part of the cleaning process the 'intervention with baseline group' data was selected, which included 8,993 participants that had access to the DBCI. The analysis below explores different ways of analysing usage data, specifically focusing on gender and perceptions of the DBCI.

8.3.1 Gender

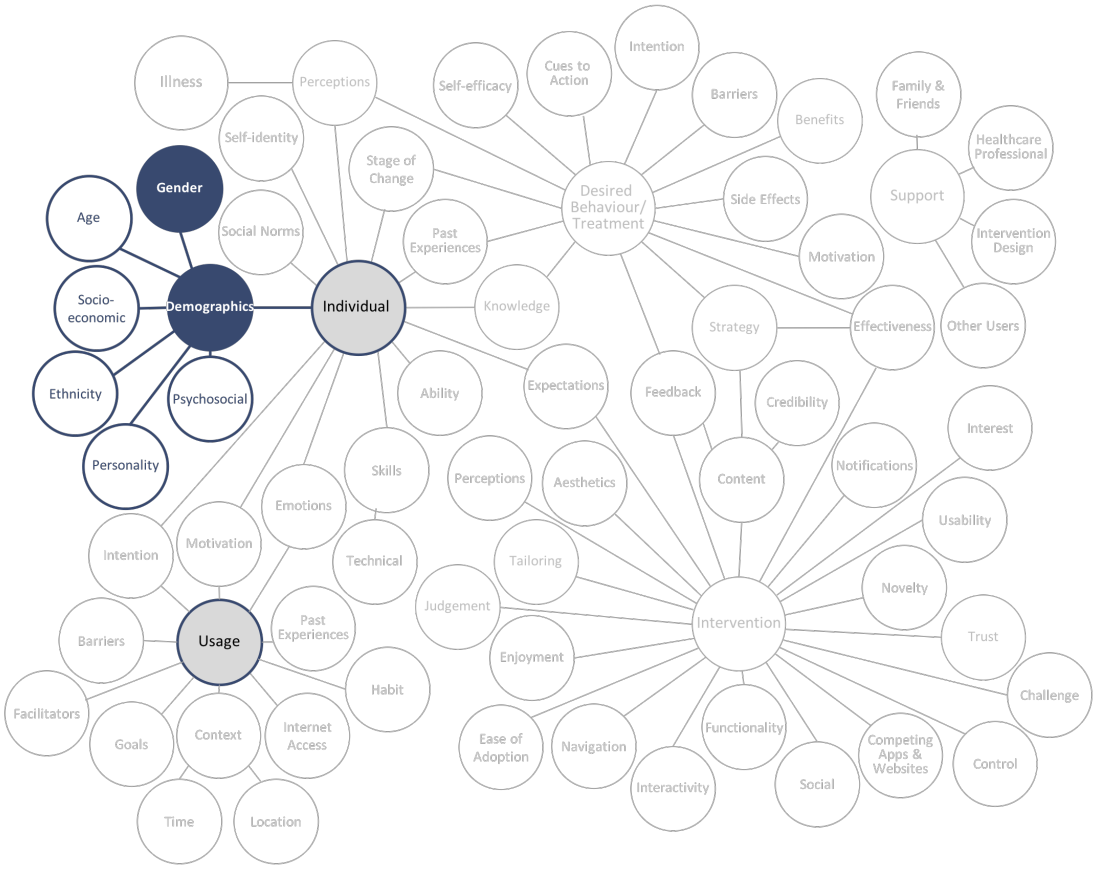

Figure 8.3: The DisENGAGE Framework highlighting the 'gender' factor for the PRIMIT case study analysis

Figure 8.3 shows the various demographic variables – including gender – that have been identified as a potential reason for disengagement. Gender was included in the DisENGAGE Framework because it was identified in both the Behaviour Change and HCI literature as a relevant factor for disengagement. Furthermore, Lange *et al.* (2003, p.904) found that significantly more males than females dropped out of their online therapy treatment. In addition, Deursen & van Dijk (2014, p.520) found that males and females tended to prefer different types of online activities; males chose news and leisure, whereas women tended to opt for online gaming. These studies further support the idea that gender may have a significant impact on disengagement and therefore this factor was particularly selected for analysis.

The gender data contained four answers: '1' (Male), '2' (Female), '1.5', and '*NA*' (*Not Available*) (see Table 8.1). All 15 individuals that did not provide their gender data also dropped out before session 1 and therefore did not impact the analysis (see Table 8.2). The '1.5' value is inconsistent data as it does not fit within the options set out by the study questionnaire. Participants may have input this value if they did not identify with the available options or they may not have wished to disclose this information. Unfortunately, it is unclear how to accurately represent this data so it has been removed from the gender based analysis.

Table 8.1: Participants grouped by gender

Gender	**Frequency**
1 (Male)	3960 (44.03%)
1.5	2 (0.02%)
2 (Female)	5016 (55.78%)
NA	15 (0.17%)
Total	8993 (100%)

Table 8.2: Participants that dropped out before Session 1, grouped by gender

Gender	**Frequency**
1 (Male)	72 (48%)
2 (Female)	63 (42%)
NA	15 (10%)
Total	150 (100%)

Table 8.3: The loss of users between sessions, grouped by gender

Gender	**Loss Between Sessions**		
	1 & 2	**2 & 3**	**3 & 4**
Male	3888-2886= 1002 (45%)	2886-2372= 514 (42%)	2372-2144= 228 (41%)
Female	4953-3748= 1205 (55%)	3748-3037= 711 (58%)	3037-2712= 325 (59%)
Total	2207 (100%)	1225 (100%)	553 (100%)

Table 8.4: A frequency table of the users at each session, grouped by gender

Gender	**Session**			
	1	**2**	**3**	**4**
Male	3888 (44%)	2886 (44%)	2372 (44%)	2144 (44%)
Female	4953 (56%)	3748 (56%)	3037 (56%)	2712 (56%)
Total	8841 (100%)	6634 (100%)	5409 (100%)	4856 (100%)

Table 8.2 shows that ~10 more males than females dropped out before session 1. Table 8.3 shows the percentage composition of males and females that dropped out between each session. This was calculated by finding the loss of each gender between each session (see Table 8.4), and then dividing this by the total loss (males and females) (also see Figure 8.4 for a visual representation of this).

Figure 8.4 visually illustrates the percentage composition of the dropout groups between each session. The percentage loss of females is slightly higher than males across all session loss. However, there does not seem to be an overwhelming difference and the small majority of female loss could be due to the fact that there were over 1000 more females, than males, in the study.

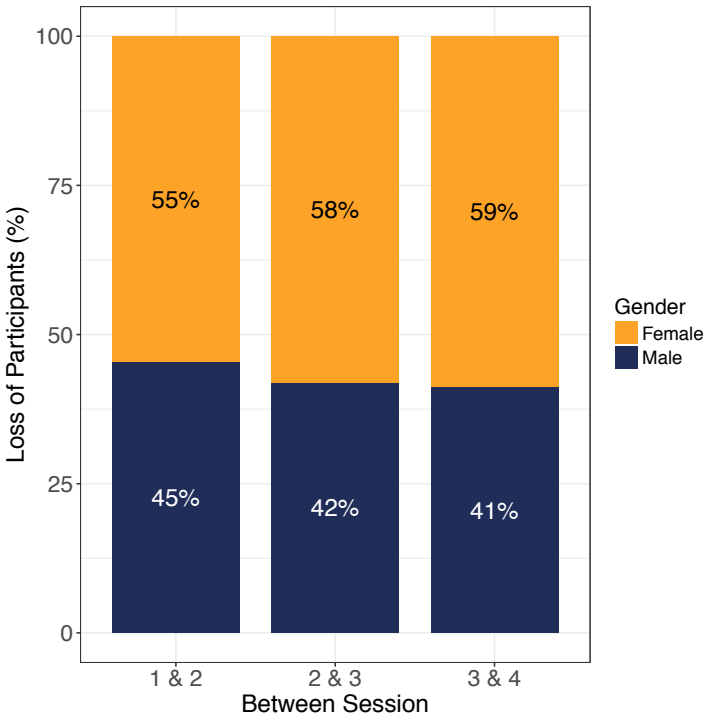

Figure 8.4: The percentage of males and females that dropped out between each session

The composition of dropouts did not indicate a noteworthy difference between genders. Each dropout group seemed to contain a similar percentage of males and females. This suggests that the intervention appealed equally to both males and females and that there was no need to tailor the content based on gender. However, this type of graph does not provide any details about the rate of dropout over the different sessions.

A non-usage attrition curve – proposed by Eysenbach (2005) – provides a rate of dropout in comparison to the starting population at session 1. This method of analysis has been used by many researchers of non-usage attrition including Wanner *et al.* (2010) and Neve *et al.* (2010) and will provide a different perspective on this data. This type of graph can highlight significant points of dropout indicating a potential problem with the intervention content or one of the intervention features.

A non-usage attrition rate is calculated by dividing the number of participants in each session by the original sample size at session 1 (see Table 8.5). These total values were selected rather than the pre-session 1 totals because this specific part of the analysis is exploring whether the 'intervention' related factors (such as content or design) had an

Table 8.5: The proportions of remaining users at each session, grouped by gender

Rating	Session			
	1	2	3	4
Male	3888/3888=1	2886/3888=0.742	2372/3888=0.610	2144/3888=0.551
Female	4953/4953=1	3748/4953=0.757	3037/4953=0.613	2712/4953=0.548

impact on dropout rather than 'individual' factors (such as stage of change). From this data set it is unclear whether the pre-session 1 participants looked at the DBCI, and therefore their inclusion in this analysis could be misleading. Instead this analysis only includes participants who definitely used the DBCI – illustrated by their completion of session 1. This type of calculation shows that males had a continuation rate of 74% and females 76% at session 2. There seems to be a similar non-usage attrition rate between genders with a continuation rate of 55% and 55% at session 4.

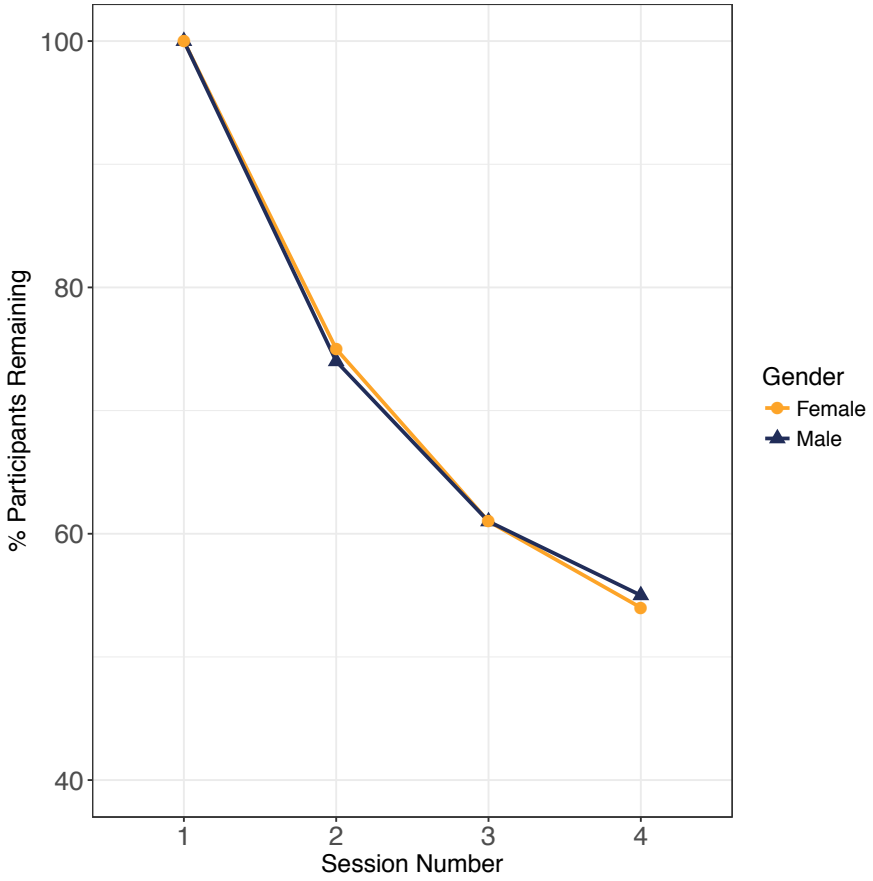

Figure 8.5: A graph to show the non-usage attrition curve of males and females

Figure 8.5 suggests that there is very little difference between the non-usage attrition rate of males and females. However, it also highlights that the rate of dropout – for both genders – was more significant between session 1 and 2, than between 3 and 4. For example, there was a loss of 26% (100%-74%) between session 1 and 2, but only a loss

of 6% (61%-55%) between session 3 and 4. This higher rate of loss at the early stages – referred to by Eysenbach (2005) as a Sigmoid Curve – could signify a dissatisfaction with the DBCI design or content. The smaller rate of loss in the latter stages potentially signifies that as users continued to use the intervention they were less likely to drop out – potentially showing a more committed group of users. Alternatively, the participants digitally disengaged after the first session because they got what they needed from the DBCI. This is supported by Ainsworth *et al.*'s (2017, p.429) finding that the biggest increase in hand washing occurred after visiting the first session.

This gender analysis did highlight that more females than males signed up for the intervention. This could be an interesting factor to explore further; especially in light of the fact that the dropout rates were consistent across both groups – suggesting that males were just as interested by the content as females.

Gender did not seem to affect disengagement from the PRIMIT intervention. This does not mean that gender should be removed from the DisENGAGE Framework because this analysis explored a specific behaviour (hand washing) with a specific intervention – PRIMIT. It is possible that gender may influence dropout from a different case study. In addition this analysis shows that males were just as committed to the intervention as females and therefore researchers may wish to think about their recruitment processes to try and encourage more males to sign up at the start.

8.3.2 Perceptions of the Intervention

Participants were asked to rate their perception of the intervention, specifically whether it provided all the advice they needed (Q1) (knowledge, content), whether it was helpful (Q2) (perception, content, strategy), and whether it was trustworthy (Q3) (see Figure 8.6). These factors have been identified as potential disengagement factors and therefore will be explored in the following analysis.

These questions were not compulsory and interestingly each question had a slightly different response rate (see Table 8.6). The majority of the 150 participants that dropped out before completing session 1, did not answer any of the web rating questions (148 participants) and the two individuals who did answered 4 and 7, for all the questions. The data cleaning process involved the removal of decimal values – such as 3.5 (see Table 8.7) – because it is not clear whether the individual would have selected 3 or 4.

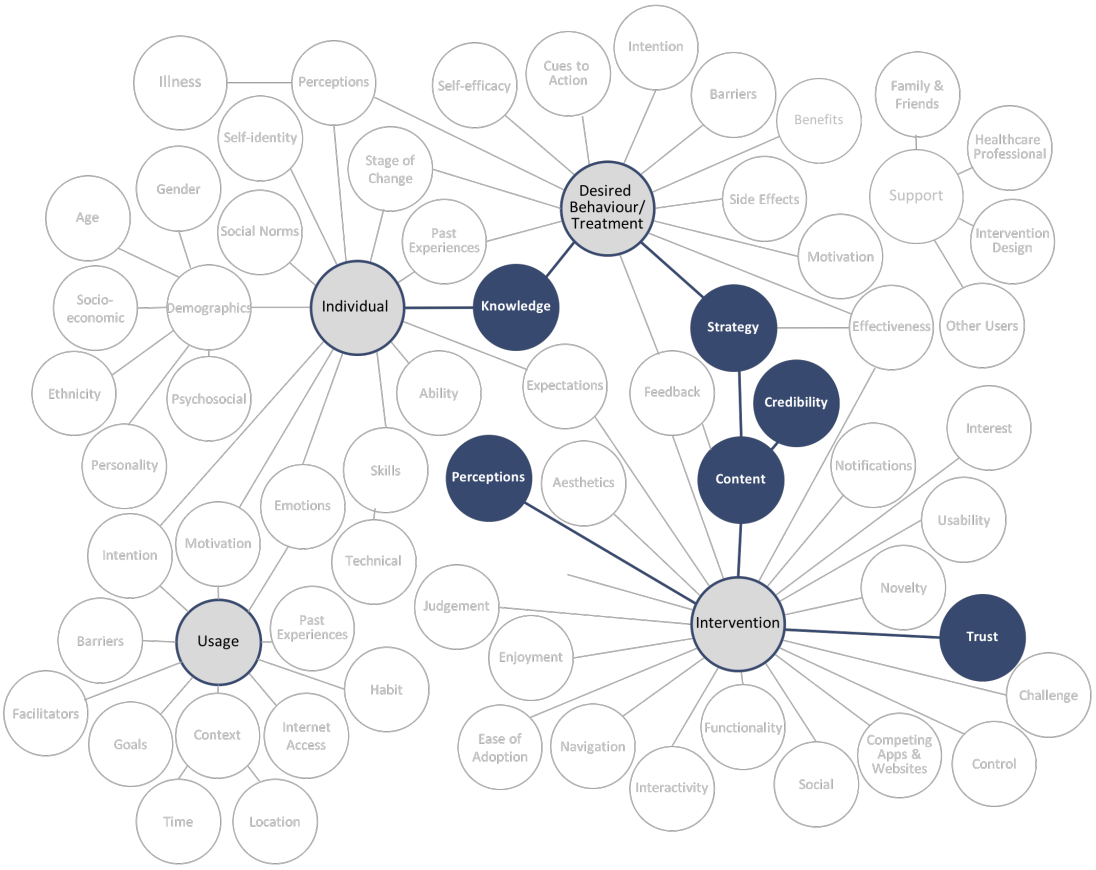

Figure 8.6: The DisENGAGE Framework highlighting the perception-related factors for the PRIMIT case study analysis

Table 8.6: The ratings of participants that completed Session 1, grouped by question

Rating	**Question**		
	1. Gave all the advice	**2. Helpful**	**3. Trust**
1 (strongly disagree)	82 (3%)	93 (3%)	88 (3%)
2	97 (3%)	113 (4%)	74 (2%)
3	70 (2%)	92 (3%)	29 (1%)
4	284 (9%)	274 (9%)	222 (7%)
5	373 (12%)	457 (14%)	316 (10%)
6	878 (27%)	813 (25%)	811 (25%)
7 (strongly agree)	1434 (45%)	1364 (43%)	1659 (52%)
Total	3218 (100%)	3206 (100%)	3199 (100%)

Table 8.7: A frequency table of Q1 ratings

Rating	**Session**			
	1	**2**	**3**	**4**
1(strongly disagree)	82 (0.93%)	74 (1.12%)	64 (1.18%)	57 (1.17%)
2	97 (1.1%)	84 (1.27%)	74 (1.37%)	67 (1.38%)
3	70 (0.79%)	60 (0.9%)	48 (0.89%)	44 (0.91%)
3.5	1 (0.01%)	1 (0.02%)	1 (0.02%)	1 (0.02%)
4	284 (3.21%)	221 (3.33%)	185 (3.42%)	168 (3.46%)
5	373 (4.22%)	322 (4.85%)	274 (5.06%)	251 (5.17%)
5.5	1 (0.01%)	1 (0.02%)	1 (0.02%)	1 (0.02%)
6	878 (9.93%)	811 (12.22%)	748 (13.82%)	702 (14.45%)
6.5	2(0.02%)	2(0.03%)	2(0.04%)	2(0.04%)
7(strongly agree)	1434(16.22%)	1348(20.31%)	1237(22.86%)	1167(24.03%)
NA	5621(63.56%)	3712(55.94%)	2777(51.32%)	2397(49.35%)
Total	8843 (100%)	6636 (100%)	5411 (100%)	4857 (100%)

This analysis is going to explore disengagement in two ways. First, Section 8.3.2.1 analyses the between-session dropout groups. This process groups the participants that did not complete the entire intervention, groups them by rating and then counts how many sessions the participants completed. From these calculations it is possible to calculate the dropout rate between each session: i.e., between 1 & 2, 2 & 3, and 3 & 4. This creates three dropout groups, which can then be analysed. Second, Section 8.3.2.2 uses the whole sample population to explore usage; participants are grouped by 'perception rating' and then by 'dropout'.

Table 8.8 draws attention to the high number of participants that did not offer a rating for this question – the '*NA*' group; this issue is explored in more depth in Section 8.3.2.3. The tables in this section refer to the ratings for the 'gave all the advice needed' question (Q1) (see Appendix D Table D.2 for Q2 and Table D.3 for Q3).

Table 8.8: The raters and *NA* responses from participants that completed Session 1

Rating	**Question**		
	1	**2**	**3**
Total	3218 (36%)	3206 (36%)	3199 (36%)
NA	5621 (64%)	5633 (64%)	5639 (64%)
Total	8839 (100%)	8839 (100%)	8838 (100%)

8.3.2.1 The Composition of Dropout Groups

Table 8.9 displays the number and percentage of participants that dropped out between each session, grouped by rating, i.e. of the 298 participants who dropped out between session 1 & 2, 8 participants rated the site a '1' for 'providing all the advice needed' (see Appendix D Table D.4 for Q2 and Table D.5 for Q3).

Table 8.9: A table to show the loss of users between sessions (Q1), grouped by rating

Rating	Loss Between Sessions		
	1 & 2	**2 & 3**	**3 & 4**
1	82-74=8 (3%)	74-64=10 (3%)	64-57=7 (4%)
2	97-84=13 (4%)	84-74=10 (3%)	74-67=7 (4%)
3	70-60=10 (3%)	60-48=12 (4%)	48-44=4 (2%)
4	284-221=63 (21%)	221-185=36 (12%)	185-168=17 (10%)
5	373-322=51 (17%)	322-274=48 (17%)	274-251=23 (13%)
6	878-811=67 (22%)	811-748=63 (22%)	748-702=46 (26%)
7	1434-1348=86 (29%)	1348-1237=111 (38%)	1237-1167=70 (40%)
Total	298 (100%)	290 (100%)	174 (100%)

Figure 8.7 shows the dropout group between each session – as a percentage – grouped by rating. The largest percentage of the dropout group – across all questions and sessions – seems to be from those rating the site a 6 or a 7 (strongly agree). For example, of the session '1 & 2' dropout group (see Figure 8.7 Graph Q1), 29% had rated the site a 7, compared to the 3% that rated it a '1' (strongly disagree). In comparison, the percentage of dropouts from rating groups 1-3 seems fairly consistent (across the sessions) between 2% and 4% each for Q1 (see Table 8.9).

Furthermore, of the participants that dropped out between session '3 & 4', 40% rated the site a 7 (Q1 - 'gave all the advice needed'). However, this higher rating would be expected if users thought all the required information had been provided, so they must have dropped out for another reason; for example, they may have liked the content but found the navigation difficult to understand. This pattern of dropouts from high raters is also shown in Graph Q2 and Q3. Graph Q3 shows 50% of the dropouts between session 3 and 4 rated the site as 7 out of 7 for trustworthiness.

These graphs suggest that ratings were not a good indicator of whether participants were likely to terminate their DBCI usage. Participants did not seem to drop out due to these three factors: gave all the advice needed, helpfulness, and trustworthiness. These graphs show the composition of the between session dropout groups, but do not show how these numbers relate to the total sample population. For example, although 86 participants

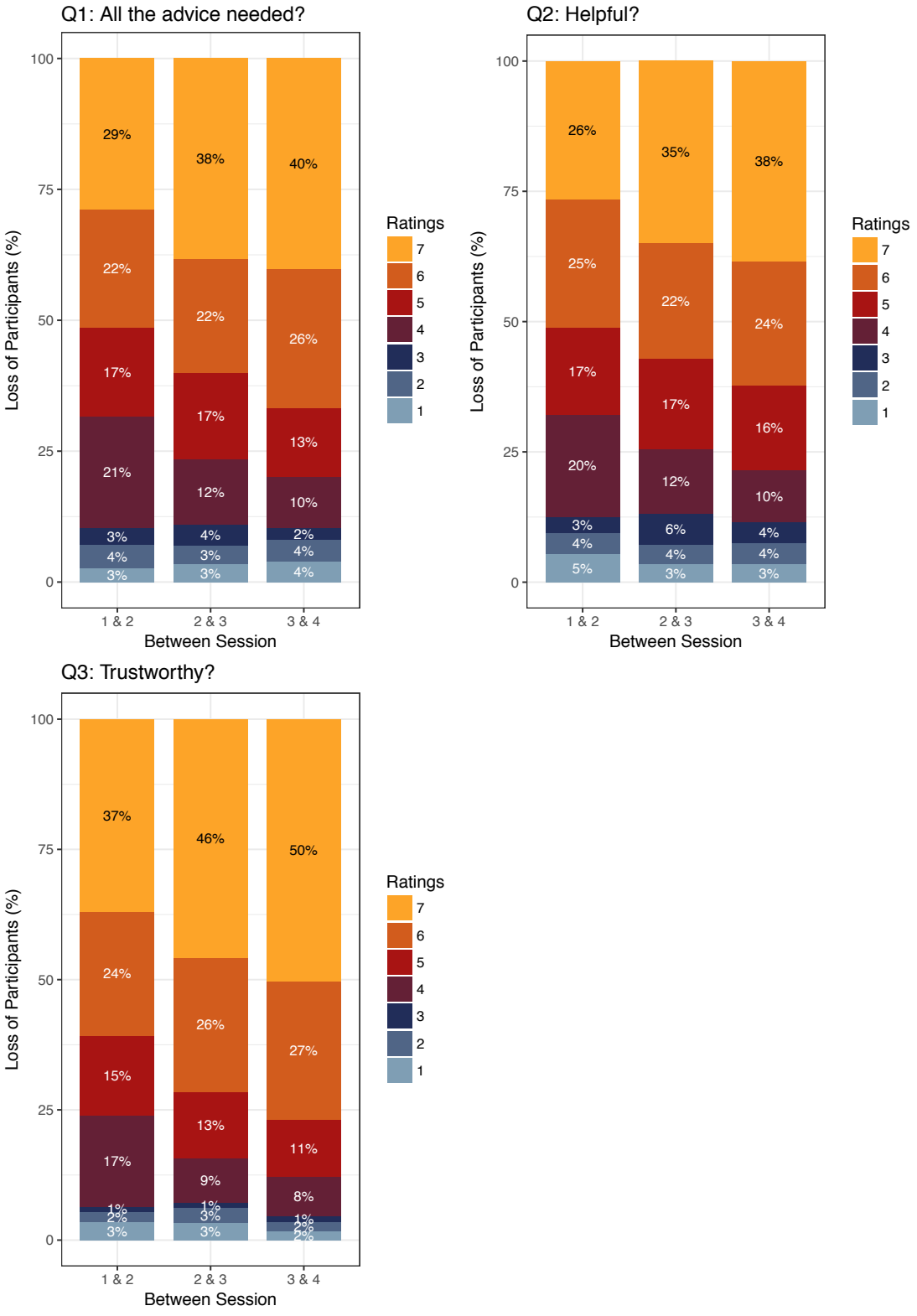

Figure 8.7: Graphs Q1-Q3 showing the percentage composition of each between-session dropout population, grouped by rating

(29%) of the dropouts were from rating group 7, this was only 6% (86/1434=0.0600 (3SF)) of that rating group (see Table 8.9).

The rating group sizes range significantly – for example 1434 participants rated Q1 a 7 compared to 70 participants in rating group 3. The loss of 86 participants from rating 7 is therefore less significant than a loss of that number from a smaller group – for example rating 2 which contains 97 participants, a loss of 89% (86/97 = 0.887 (3SF)). The non-usage attrition graphs – which will be explored in the next section – use an attrition rate which takes into account the group size.

8.3.2.2 Non-usage Attrition Curves

Table 8.10 explains how the non-usage attrition rate was calculated – dividing the number of 'completers' for each session by the session 1 group size (see Appendix D Table D.6 for Q2 and Table D.7 for Q3 calculations). Figure 8.8 shows the proportion of remaining users – grouped by rating – over the four sessions. Graph Q1 seems to suggest that the individuals who rated the site as 'providing all the required advice' (rating of 7), were more likely to continue to use the intervention – non-usage attrition rate of 0.814 at session 4 (see Table 8.10).

Table 8.10: The proportions of remaining users at each session, grouped by Q1 rating

Rating	**Session**			
	1	**2**	**3**	**4**
1	82/82=1	74/82=0.902	64/82=0.780	57/82=0.695
2	97/97=1	84/97=0.866	74/97=0.763	67/97=0.691
3	70/70=1	60/70=0.857	48/70=0.686	44/70=0.629
4	284/284=1	221/284=0.778	185/284=0.651	168/284=0.592
5	373/373=1	322/373=0.863	274/373=0.735	251/373=0.673
6	878/878=1	811/878=0.924	748/878=0.852	702/878=0.800
7	1434/1434=1	1348/1434=0.940	1237/1434=0.863	1167/1434=0.814
NA	5621/5621=1	3712/5621=0.660	2777/5621=0.494	2397/5621=0.426

The rating that appeared to have the second highest continuation across all four sessions was rating 6, also supporting this hypothesis. However, the graph suggests that the third and forth highest continuation rates were from the rating 1 and rating 2 groups, the worst two ratings. The two extremes presented the best continuation rates which implies that poor ratings (1 and 2) do not necessarily lead to disengagement. Surprisingly, the highest dropout rate at session 4 (~60%) was the rating 4 group, the middle rating of 'undecided' or 'neither disagree nor agree'. This may indicate a lack of interest in the DBCI or the study.

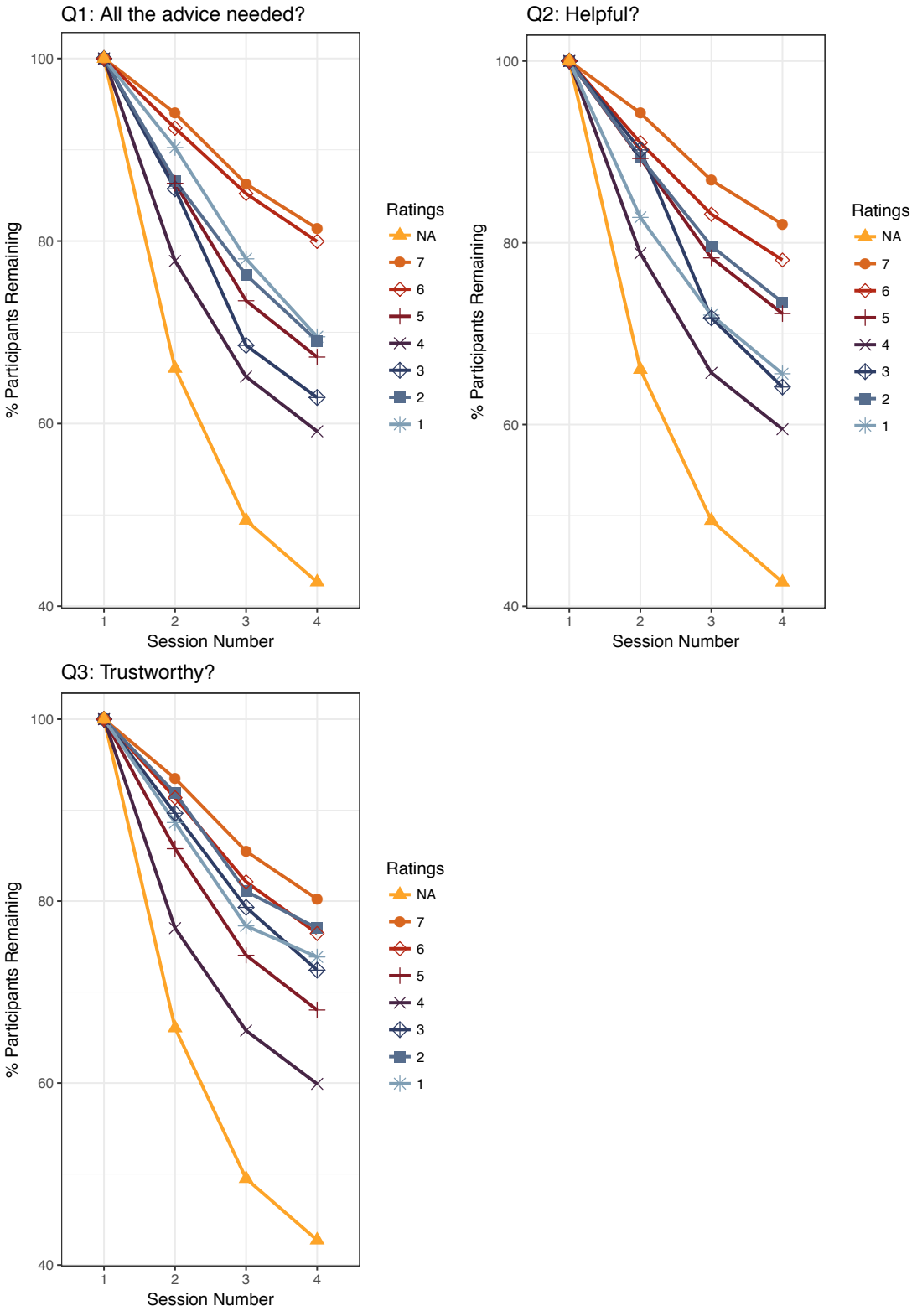

Figure 8.8: Graphs Q1-Q3 to show the non-usage attrition curves, grouped by rating

These non-usage attrition rates seem to suggest that for the majority of participants, the 'quantity and completeness of advice' was not a crucial factor when deciding whether to continue or terminate their use of the intervention. Potentially participants preferred what they considered 'incomplete' information to the alternative of no information. The lack of 'complete advice' could have contributed to the larger dropout rate in the *NA* group, which had a continuation of only 43%. However, without further information regarding this group's experience, it is impossible to know the importance of this factor.

Graph Q2 (Figure 8.8) shows a similar pattern of continuation with ratings of 7 and 6 appearing to show better rates of completion and ratings of 3 and 4 showing the worst. At session 2, rating 3 appears to be producing the third highest rate of continuation but this drops by 0.185 (nearly 19%) by session 3. The loss of participants at this stage might highlight an issue with session 2 or 3 potentially signifying dissatisfaction with the quantity and/or completeness of the information.

Graph Q3 (Figure 8.8) does not seem to follow the same trend as the other two graphs, as the top two continuing rating groups appear to be 7 and 2. However, there is only a difference of 0.6% (0.770-0.764=0.006) between rating 2 and 6 and this would not appear to have statistical significance. The high rate of completion by rating 2 participants (74%) indicates that trustworthiness may not have been an important influence on whether an individual decided to continue or terminate use.

The lowest non-usage attrition rate – lowest rate of continuation (~43% for all three questions) – was the *NA* group; participants that did not provide ratings. It is often difficult to gather data from dropouts as a high proportion of these participants are also lost to follow-up questionnaires. This volume of loss highlights the importance of appropriate data collection for disengagement research. The lowest continuation rate from the raters groups was ~60% (rating 4) across all three questions; 17% better than the *NA* group's continuation rate of ~43%.

These rating questions have explored a number of the DisENGAGE Framework factors, including content, perception (gave all the advice needed), helpfulness (perception, content, strategy), and trustworthy (trust, credibility). However, this analysis has highlighted the issue of incomplete data which makes it difficult to draw strong conclusions. If any of these factors had shown a higher rate of dropout it could have provided guidance for future iterations of the intervention. For example, if the highest dropout was from participants who stated the intervention lacked 'completeness' (Q1 with a rating of 1), intervention designers could have addressed this in future iterations of the DBCI. However, this analysis did highlight a significant difference between the raters and the *NA* group. The following section compares these two groups to develop a better understanding of the composition of dropouts from the PRIMIT intervention.

8.3.2.3 Raters and *NA* Groups

The majority of users did not answer the web perception questions: 5621 (Q1) (see Table 8.11), 5633 (Q2) (see Appendix D Table D.8), and 5639 (Q3) (see Appendix D Table D.9) out of a sample of 8,993. In general individuals who opted to answer one of the optional questions, tended to answer all of them. For Q1 the loss of participants within the rater groups are in the hundreds, compared to the thousands in the *NA* group (see Table 8.12). This is also the case for Q2 and Q3 (see Appendix D Table D.8 and D.9).

Table 8.11: The number of participants who did or did not provide a rating for Q1

Group	**Session**			
	1	**2**	**3**	**4**
Raters	3218 (36%)	2920 (44%)	2630 (49%)	2456 (51%)
NA	5621 (64%)	3712 (56%)	2777 (51%)	2397 (49%)
Total	8839 (100%)	6632 (100%)	5407 (100%)	4853 (100%)

Table 8.12: The number of participants that dropped out, grouped by raters and *NA* for Q1

Group	**Loss Between Sessions**		
	1 & 2	**2 & 3**	**3 & 4**
Raters	3218-2920=298 (14%)	2920-2630=290 (24%)	2630-2456=174 (31%)
NA	5621-3712=1909 (86%)	3712-2777=935 (76%)	2777-2397=380 (69%)
Total	2207 (100%)	1225 (100%)	554 (100%)

Figure 8.9 shows the percentage of users who dropped out between each session in respect to that groups population, i.e. 34% of the *NA* group dropped out between session '1 & 2'. This graph represents all three rating questions because the calculations produced the same loss of *NA* and raters (see Appendix D Table D.12 for the full calculations).

For the participants in the raters group there was a fairly consistent rate of loss, between 7% and 10%. However, the *NA* group lost the most participants at the beginning – between session '1 & 2' – and this rate of loss reduced over time. This highlights early digital disengagement, potentially due to unmet expectations or a lack of intention for usage. The loss of 34% – of the *NA* group – between session '1 & 2' is a loss of 22% of the entire population of participants ((1909/8843)x100 = 21.5877).

This significant loss of participants and proportion of the sample population highlights the importance of disengagement research. Disengagement related data could provide

vital information about why the users dropped out; this could guide future iterations of the DBCI hopefully resulting in fewer dropouts by participants in the future.

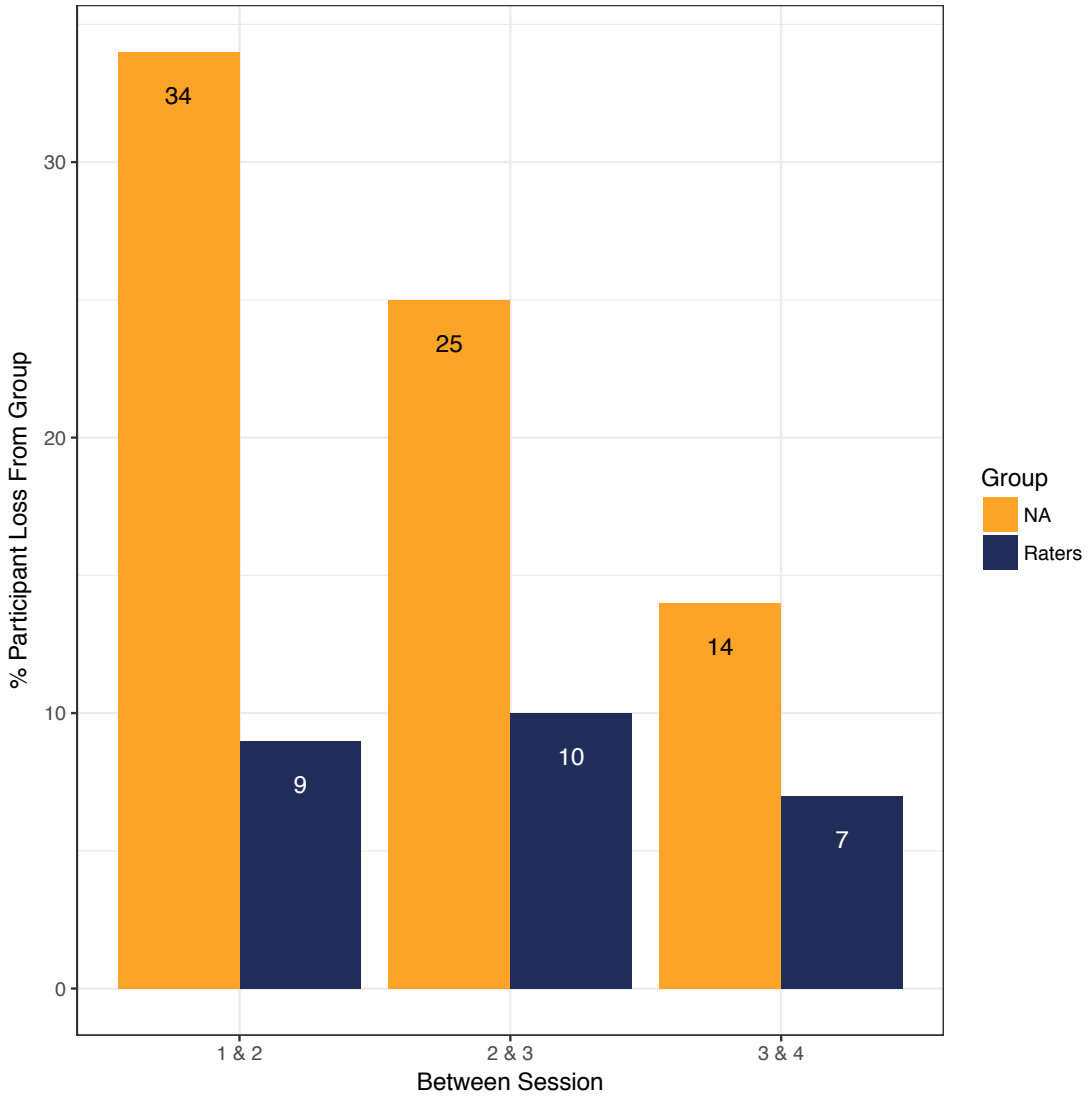

Figure 8.9: A graph to show the percentage of dropouts between each session in respect to that groups population

8.3.3 Summary and Discussion

The original aim of the PRIMIT study was not to examine patterns of disengagement from an intervention but rather investigate whether a DBCI reduced the frequency of respiratory tract infections (RTIs) among adults and within their households. Participants were asked a range of questions relating to gender, age, education, behavioural intention and depression. Perception was not the focus of the study and although some data was collected to investigate this, it was limited. As always further data would

have provided a clearer explanation for why individuals disengaged. However, this requires planning and consciously setting disengagement research as one of the experiment objectives. This is what the DisENGAGE Framework aims to facilitate.

This data did not provide the evidence for any strong conclusions relating to gender or perception. There did not seem to be a significant difference between the dropouts of males and females. However, it was difficult to draw conclusions relating to these perceptions as there was a lack of data from the *NA* group – the group with the highest rate of dropout.

This analysis did highlight that researchers need to plan for disengagement data – specifically the point as well as the method of collection. The first data collection issue relates to the point of data collection. The web perception questions were sent out in the follow-up questionnaire at 16 weeks, which may have been weeks after the individual digitally disengaged. These participants may have only used the site once and this could have been in the first week, potentially 15 weeks before they received the follow-up questionnaire. Unless the individual had recently completed the intervention, their perceptions would be based on old memories and may not provide the level of detail required to rate the DBCI accurately.

The fact that the three web perception questions were not compulsory, creates the second issue. This resulted in low response rates: Q1 36% (3218/8843), Q2 36% (3206/8843), and Q3 36% (3199/8843) which meant a significant loss of valuable disengagement data (see Table 8.6). However, making too many questions compulsory can result in participants dropping out of the study without providing any follow-up data. This can result in the loss of data for primary research objectives and therefore the design of the questionnaire has to be well thought through.

Surprisingly, participants did not always answer all three questions; for example, ID 17273 answered Q1 and Q2 but not Q3. This individual scored the first two questions with a middle and high rating – Q1=5 and Q2=7 – and therefore one explanation for the missing value could be due to response bias. If the individual was thinking of rating Q3 lower than Q1 and Q2, they may have decided to leave the answer blank rather than 'disappoint' the researcher. Equally, the individual may simply have become bored or distracted when answering the questionnaire and this may explain their lack of answer. Alternatively the participant may not have understood the question or understood its relevance. This is all speculation because the questions were not compulsory. To collect this vital disengagement data researchers need to identify the important questions and either make these compulsory or – where appropriate – ask these earlier on in the study. Additionally, identifying other methods for data collection rather than exit questionnaires – such as short interactive quizzes in the DBCI content – may help to minimise the loss of valuable disengagement data. Unfortunately, these low response rates limit

the validity of conclusions as the data only represents a small proportion of the overall population.

There are some important implications arising from the suggestions made in this section. If researchers try and collect data too often participants may find this intrusive and irritating, which could lead to more participants disengaging. Equally, making questions compulsory could lead to participants failing to complete any of the questionnaire. It will therefore be important for researchers to plan and consider their data requests, aided by the DisENGAGE Framework. Furthermore, it is clear from the research in previous sections, that dropout is a significant issue for DBCI studies and without this disengagement data, intervention designers will find it difficult to address the causes of dropout.

Chapter 9

Case Study 2: CIRCA and the DisENGAGE Framework

Chapter 8 explored various factors relating to disengagement from a large-scale study called PRIMIT. This disengagement analysis segmented the entire participant sample according to their gender and various perceptions about the intervention. This provided a macro-level exploration of factors leading to DBCI disengagement. Furthermore, the PRIMIT case study examined a session-based intervention, which was designed to be used over a series of weeks.

In comparison, this chapter – case study 2 – analyses the usage data of a small sample of participants (30 individuals), enabling a greater depth of individual analysis and a micro-level exploration of disengagement. In addition, CIRCA was designed as a self-help tool, providing a 'use when needed' service. These differences between the case studies, in terms of the type of intervention, sample size, and the selected disengagement factors, help to provide different examples of how the DisENGAGE Framework can be used for disengagement research.

This analysis uses the DisENGAGE Framework, to better understand disengagement from a voluntary DBCI, addressing RA3 ('to investigate how qualitative and quantitative (usage) data can be used to understand disengagement using the framework'). Section 9.1 introduces the original study, its context, and objectives. Section 9.2 provides a brief overview of the intervention, its contents and some example screenshots. Section 9.3 analyses the usage data to identify interesting patterns of usage. These usage patterns are then explored using the DisENGAGE Framework to identify a number of disengagement factors, including the inaccessibility of certain content, potential disinterest in the DBCI, logging in issues, and the impact of notifications.

9.1 The Original Study

In 2016, Cullington *et al.* conducted a six month feasibility trial to test the remote care tool – 'Cochlear Implant Remote CAre' (CIRCA). The study took place during the first half of 2016 and involved 60 participants, 30 in the remote care group and 30 in the control. Participants ranged in age from 20 to 83, with 36 females and 24 males (Cullington *et al.*, 2016, p.10).

The CIRCA research was set up to support recipients of cochlear implants. These medical devices help individuals, who are severely deaf, to hear (Cullington *et al.*, 2016, p.1). There are ~14,000 patients in the UK with this type of implant and this number is increasing yearly (Cullington *et al.*, 2016, p.1). During the first year of use the device requires minor adjustments, in order to discover the best settings for the individual. Rehabilitation appointments are also fairly frequent during this first year and subsequently patients have a yearly check-up (Cullington *et al.*, 2016, p.2). These yearly appointments are scheduled by the clinic, without consultation with the patient and regardless of whether one is required (Cullington *et al.*, 2016, p.2). As a result, these check-ups can sometimes be unnecessary and may not be the most effective use of the clinic's or patient's time. The project aimed to increase the patients' feelings of empowerment. It encouraged individuals to monitor their own hearing and take action when required. If successful it would reduce the potentially unnecessary yearly appointments, freeing up clinic time for patients who have identified a problem with their implant.

This primary research objective (patients' feelings of empowerment) was tested using the Patient Activation Measure (PAM). However, secondary objectives also measured changes in stability of hearing, quality of life whilst using CIRCA, and personal feelings about the remote care tool versus traditional face-to-face services. Cullington (2016, p.3) found the PAM score to be unchanged in both the control and intervention group. However, the PAM questionnaire initially used in this study was designed to test empowerment levels with a pharmacological – rather than technological – intervention. This therefore may not have been a valid measurement for this study (Cullington, 2016, p.11). Cullington did find an increase in empowerment levels of the remote care group using the Cochlear Implant Empowerment Measure (CI-EMP) – an empowerment measure designed to test patient activation levels after receiving the CIRCA tool. The study also found an increase in hearing stability for the remote care group and patients were keen to continue with the remote care tool.

This intervention did not have a set number of compulsory sessions. Instead, patients were encouraged to use the DBCI if and when it was required. It therefore aimed to offer 24-hour support for individuals to self-manage their hearing.

Cullington (2016) reported a dropout attrition rate of only 2%. This rate was calculated from the number of participants who dropped out before the final data collection point,

which was the follow-up questionnaire at six months. This is a very low rate of dropout and therefore an interesting data set to analyse. The following section presents the CIRCA intervention.

9.2 The Intervention

The CIRCA intervention was designed and developed using the LifeGuide software (see Section 7.3.1). It contained a series of information pages and external links to cochlear implant support pages. This section will explain the page flow and present some examples of intervention content.

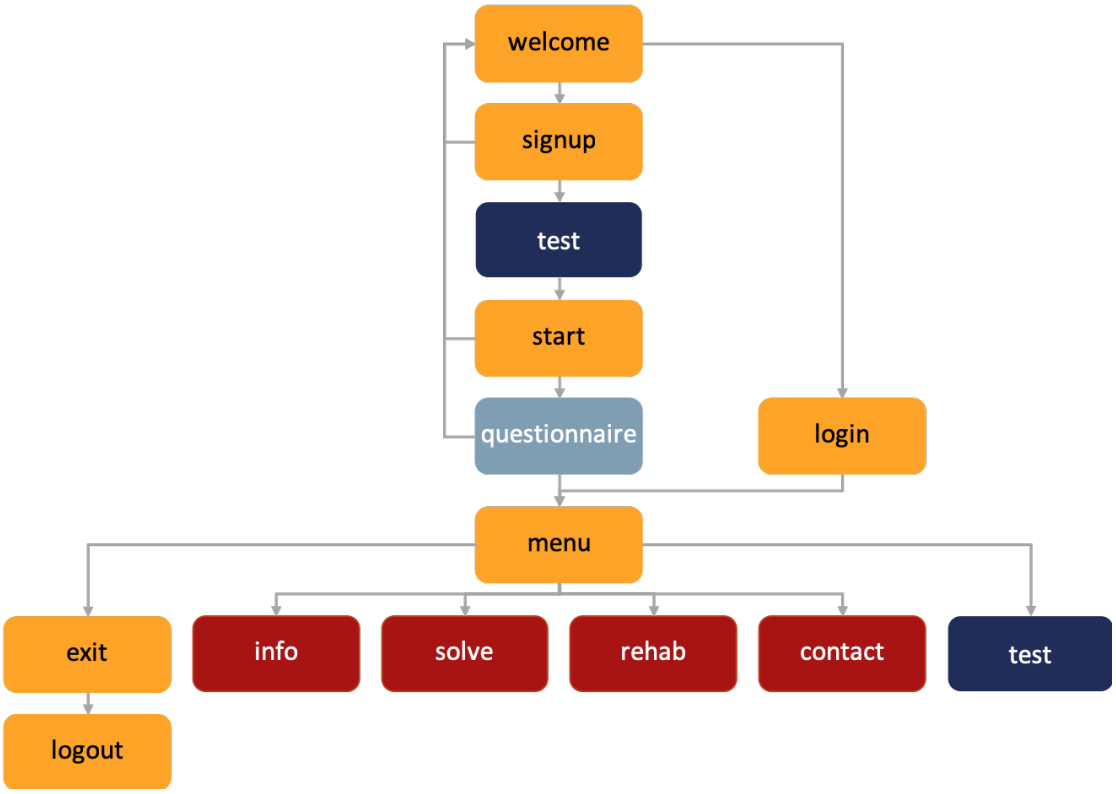

Figure 9.1: Page flow from 'Welcome' to 'Menu' options

The first screen of the CIRCA intervention was the 'Welcome' page, which offered users the choice of signing up or logging in (see Figure 9.1). First time users were guided through a series of signup screens before being directed to an external hearing test (based on the Triple Digit Test (TDT)) which was maintained by the 'Action on Hearing Loss'[1] website.

Once the hearing test had been completed, participants were asked to input their test 'score' into the intervention (see Figure 9.2). Following this participants were required to complete five questionnaire pages. Questions related to the comfort of the cochlear

[1] https://www.actiononhearingloss.org.uk

implant, quality of hearing, hours it was worn, and the overall condition of the equipment. Participants were not told in advance the number of questions in the welcome questionnaire. This tunnelled page flow was used to ensure participants completed all the questions before continuing to the main site.

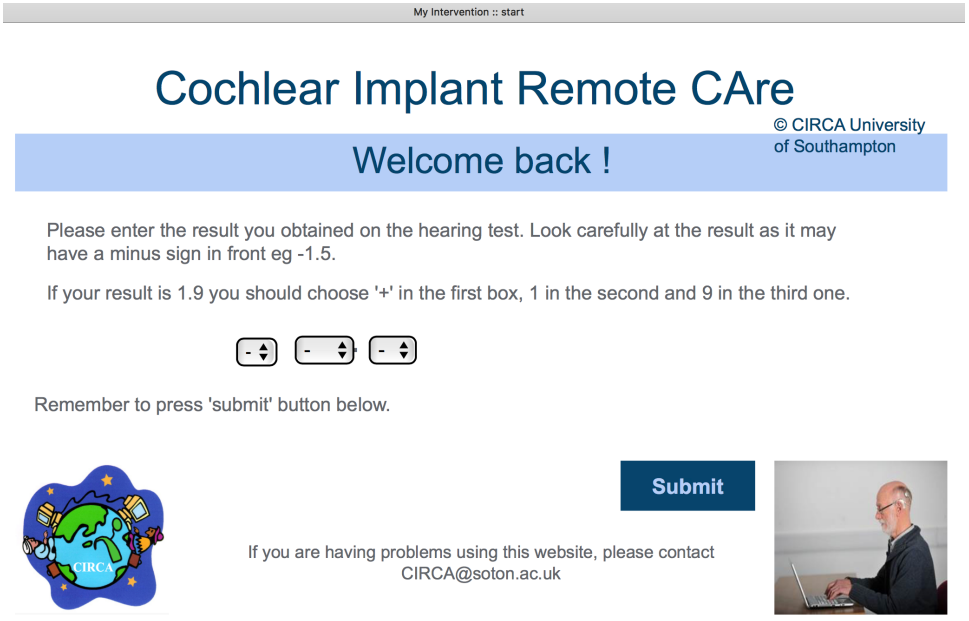

Figure 9.2: CIRCA 'Welcome back!' page

If a user did not complete all five questionnaire pages in one session, they were redirected to the first 'test' page on their return to the DBCI. Once the questionnaire was completed the user was directed to the menu page after login (see Figure 9.3). The only exception to this page flow was at six months when participants were asked to complete the follow-up questionnaire. They were directed back to the first 'test' page before being shown the questionnaire pages.

There was an 'exit' button on the right-hand side of every page, providing users with a way to leave the intervention regardless of where they were in the system. In addition there was also a 'back' button on the left-hand side of each screen. This took the user to the previous page. The menu offered several options including: 'Solve a problem or get help', 'Do some rehab', 'Get info or training', 'Test your hearing', and 'Contact'. Each menu option had additional sub-levels and intervention content. These areas will be briefly explained below.

The 'Solve a problem or get help' section contained five pages: 'Medical', 'Equipment', 'Worried or depressed about your hearing', 'Not hearing so well', and 'Problems with this website' (see Figure 9.4). This is going to be used as an illustration of the type of content offered by CIRCA.

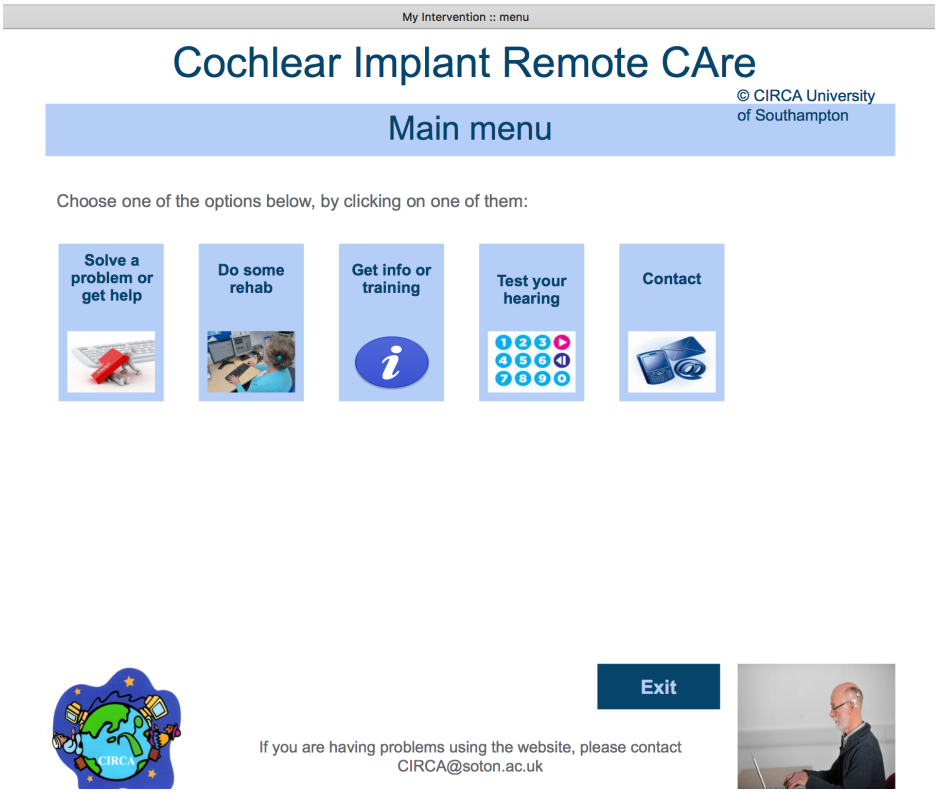

Figure 9.3: CIRCA 'Menu' page

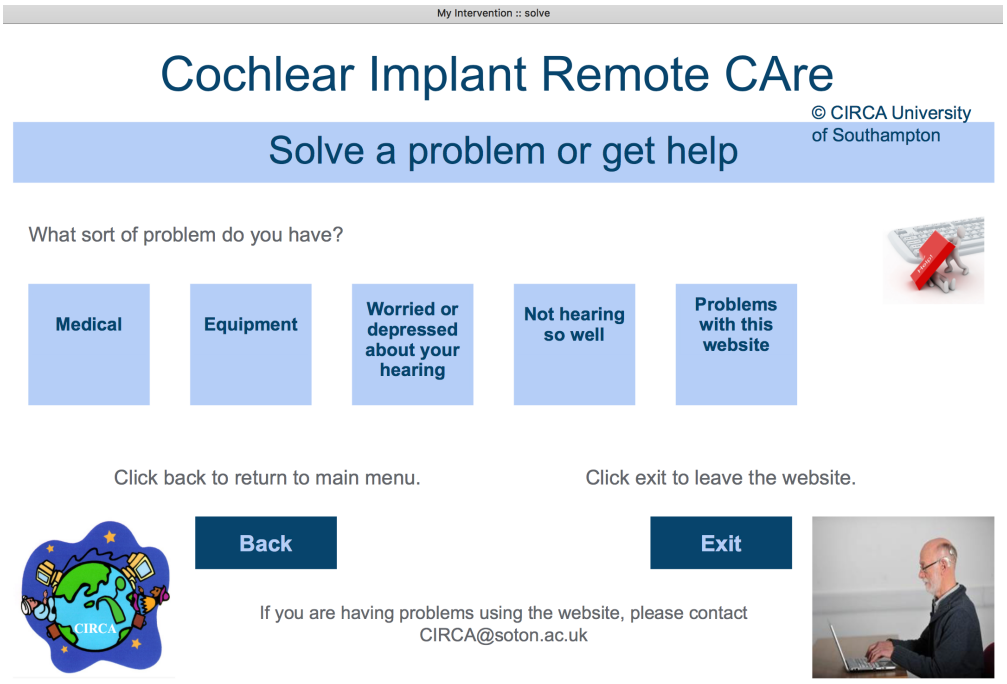

Figure 9.4: CIRCA 'Solve a problem or get help' page

The 'Medical' page was a static page of helpful information regarding medical problems. It included advice to ring 999 in an emergency, common issues relating to the cochlear implant (such as swelling or redness), and contact details for the University of Southampton Auditory Implant Service or local support centre. The 'Equipment' page had a series of additional pages which are explained in the following table (see Table 9.1). The 'Worried or depressed about your hearing' page provided participants with some ideas for practical support and places to seek help if they were feeling worried or depressed - these included links to the team psychologists, befriending services and the 'British Society for Mental Health and Deafness'. The 'Not hearing so well' page offered some troubleshooting options such as the link to the hearing test, troubleshooting guides for the implants and a link to contact their centre. 'Problems with this website' is a simple page with contact details for the lead researcher.

Table 9.1: An explanation of the pages in the 'Equipment' section of the CIRCA intervention

Page	**Page Description**
Need replacement equipment	Form asking for details of the equipment that needed replacing. This was forwarded to the appropriate centre.
Something's not working	Advice to look at the troubleshooting guide for the specific model of implant and a link (to an external support site).
Help with equipment	There were three additional options: 'I need help using my equipment', 'How to keep my processor dry', and 'I have lost my processor'. All of these offered some advice or links to manuals, the patient's cochlear implant centre or a link to a replacement form.
Order holiday loaner	Information about how and where to look to borrow equipment, including helpful links.
Help with accessories for work or home	Information about accessories for work and home life, including links to the 'Government Access to Work Scheme' and 'Action on Hearing Loss'.
Am I due an upgrade?	Information about the regularity of upgrades and a count of the number of years the participant had had their particular implant for.

The 'Do some rehab' section offered the option for users to set a hearing related goal, provided advice and practical tasks related to using the telephone, listening to music, listening practice, using accessories, and guidance for wearing a speech processor more. The 'Get info or training' area offered general information about implants, the specific speech processor used by the individual, advice regarding MRIs and airports, rehabilitation, other training, and information about the research study. The 'Test your hearing'

option redirected the user to the hearing test and finally the 'Contact' page provided a number of hearing related charity contacts and support groups.

Each section provided written content and various links to external sites. Content was also tailored to the individual's cochlear implant speech processor and cochlear implant centre.

9.3 The Disengagement Analysis

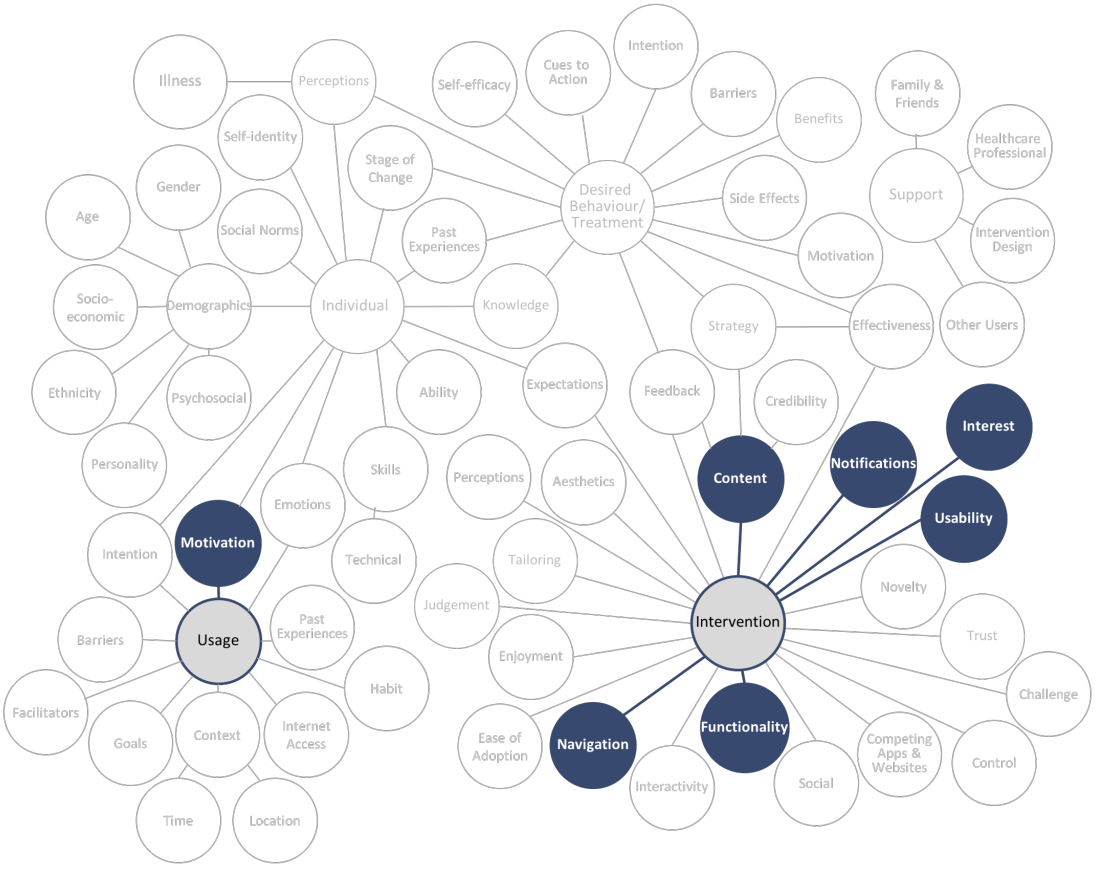

Figure 9.5: The DisENGAGE Framework highlighting the factors that will be explored in the CIRCA case study

This disengagement analysis retrospectively explores a number of disengagement factors including 'navigation', 'functionality', 'usability', and 'notifications' (see Figure 9.5) and in doing so investigate the 2% dropout rate. Only one participant (Telemed9) contacted the principal researcher (after 2 months) to dropout of the study (Cullington, 2016, p.16). This participant reported having 'lots of problems with checking in on the computer' and stated that they would 'much prefer to meet someone and [be] face to face' (Cullington, 2016, p.16). This low rate of dropout suggests that the DBCI was successful in supporting patients and was fit for purpose. This analysis aims to explore this assumption.

This data analysis followed the data cleaning and reshaping processes explained in Section 7.3.4. Various users – Telemed43, Telemed44, Telemed45, Telemed47, Telemed48, and Telemed49 – were removed from the data before analysis because these profiles were used by the intervention designers and researchers and therefore did not contain participant data.

The data also contained some 'obvious' inconsistencies as Telemed10 accidentally started logging in using Telemed19's profile. Telemed19 was therefore given a new username – 'Telemed42'. A quick exploration of the data revealed that the original Telemed19 user had not starting using the system yet and therefore all references to this username in the database were actually referring to Telemed10. This data was therefore corrected by renaming any Telemed19 data as Telemed10 and leaving Telemed42 as it was.

There was also a single entry where a participant attempted to signup but failed to pass the second signup page. For this reason, there was no 'user.identifier' code and therefore no accurate way of identifying which participant had created the entry; this data point was therefore removed from the database.

This DBCI was different from other interventions because there were no compulsory sessions; participants were encouraged to use it if and when they wanted. However, they were asked to use it a minimum of two times during the study. This means there was no expected pattern of usage and therefore usage patterns will be unique to each individual. The following sections explore various factors and aspects of this usage. Each section utilises a number of graphs which were generated from tailor made R scripts (explained in Section 7.3.4).

9.3.1 Logins and Page Flow

Figure 9.6 shows the logins of each user over the six month period. Telemed9 has already been identified as a dropout. However, interestingly Telemed23 and Telemed30 appear to have only logged in once – or at least have only logged in on one date. These two participants logged in fewer times than Telemed9 – the reported *dropout* – and Telemed22 logged in the same number of times as *the dropout*. This highlights the slightly misleading impact of a dropout attrition rate, where dropout is based on the completion of follow-up data collection.

This graph also highlights several participants – Telemed14, Telemed15, and Telemed42 – that have significant gaps of non-usage over the six month period. These individuals may not have needed the DBCI or their low usage rate may have been due to other factors.

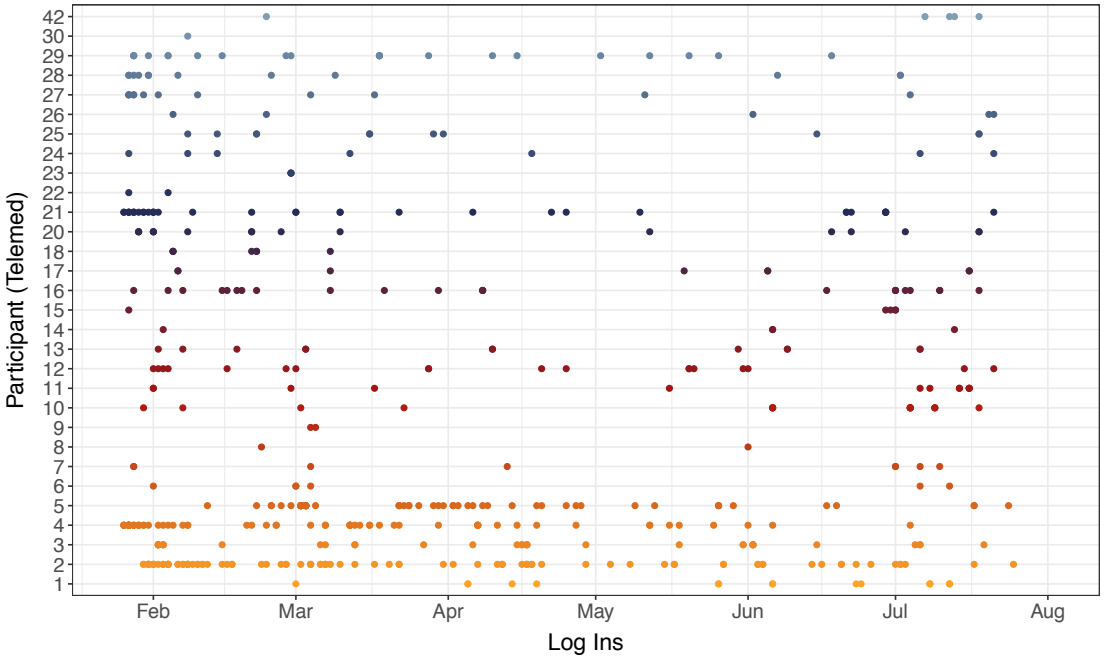

Figure 9.6: A login graph of CIRCA participants in the remote care group over the six month period

9.3.2 Exploring Usage Patterns

A categorised usage graph (explained in Section 7.3.4.3) can illustrate how a user has spent their time on an intervention (see Figure 9.7). Categories are specific to a DBCI and the CIRCA pages were grouped into four categories: 'admin', 'questionnaire', 'test', and 'intervention' (see Table 9.2). These groupings indicate the main features, functions, or areas of the site but can be tailored according to the researchers requirements and desired level of detail.

Table 9.2: Categorising pages of the CIRCA intervention

Categories	**Pages**
admin	exit, login, loginneg, logout, menu, notworking, signup, welcome
questionnaire	baselinequest, qres
test	results, start, test

Figure 9.7 shows that Telemed9, Telemed15, and Telemed23 had a similar pattern of usage; they did not look at any of the intervention pages. Telemed1 has also been included in this analysis because even though he logged on multiple times he also did not view any of the intervention pages. Without further data analysis it is difficult to understand this usage; the following sections will explore their usage in more detail.

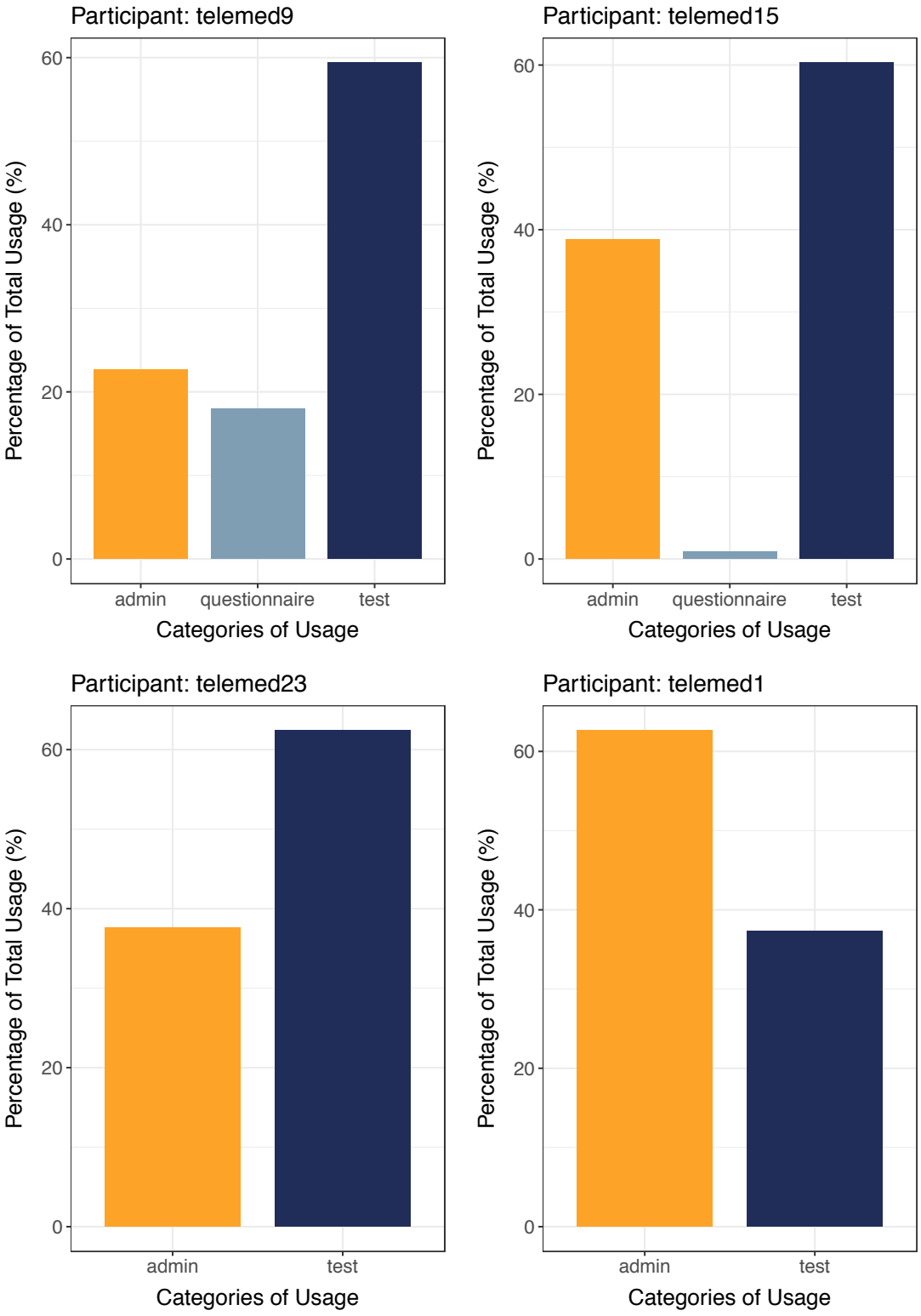

Figure 9.7: Participants' CIRCA usage grouped by page type category

9.3.2.1 *Just* Testers or Access Issues?

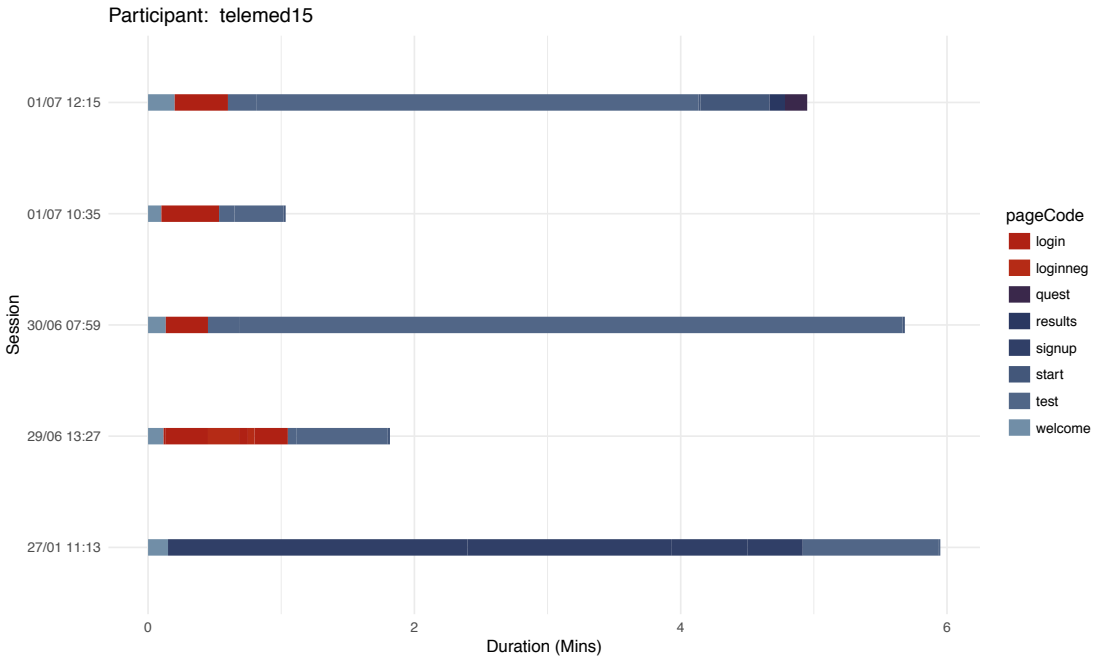

Figure 9.8: Page flow graph showing each of Telemed15's sessions and the pages visited

Figure 9.8 shows the various sessions completed by Telemed15 and highlights the fact that she did not view the 'qres' page. The 'qres' page is seen by a participant when they complete the entire questionnaire. Telemed1 and Telemed23 also did not view the 'qres' page (see Appendix E Figures E.1 and E.2). The flow through the system prevented users from accessing the main intervention content without completing the entire questionnaire; this design makes the questionnaire compulsory. However, in this instance the participants never moved beyond this point – because they did not complete the entire questionnaire – and therefore they may not have been aware of the rest of the DBCI content or functionality.

Telemed15 logged in to the system five times (twice on one day). However, during the first four sessions this individual did not move beyond the 'start' page. This page asked users to submit their results from the hearing test website. It was only during Telemed15's fifth session that she attempted a few of the questionnaire pages (see Figure 9.9). Neither Telemed1 nor Telemed23 passed the 'start' page, even though Telemed1 accessed the intervention 15 times.

These patterns of usage could have resulted from the inaccessibility of the intervention pages. This would highlight the following disengagement factors: usability, navigation, and (awareness of) functionality. However, it is possible that the user wanted the DBCI purely to test their hearing, relating to the user's motivations and DBCI usage goals (see Figure 9.10).

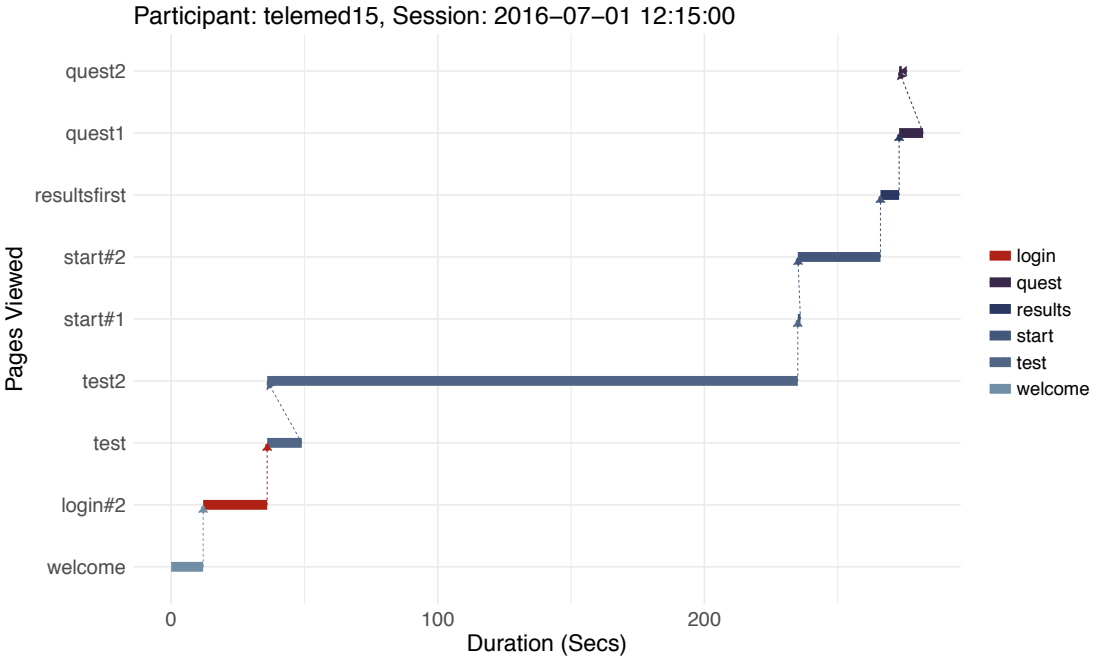

Figure 9.9: Page flow graph of Telemed15's 5th session

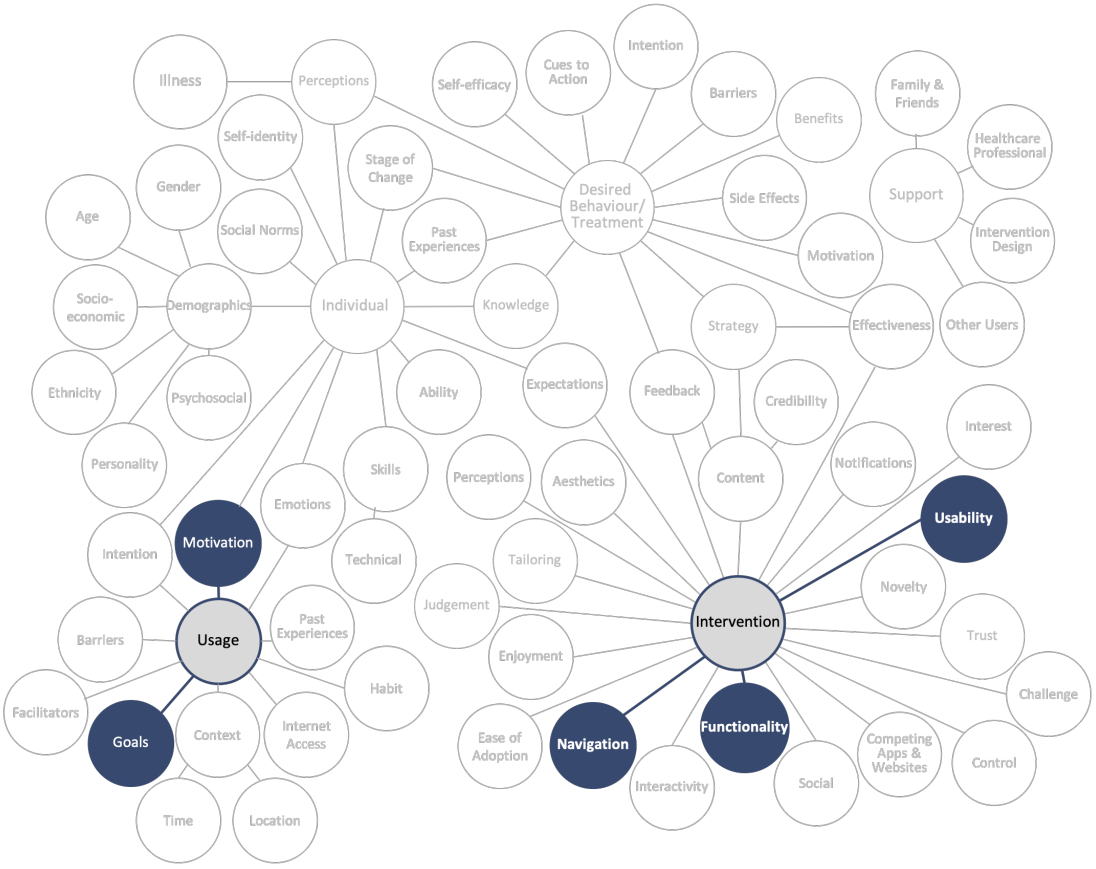

Figure 9.10: The DisENGAGE Framework highlighting the factors relating to the navigation and functionality of the CIRCA DBCI

Telemed1 clearly wanted to test his hearing as he returned 15 times to the intervention to do so. However, due to this access issue it is likely that he was unaware of the other DBCI functionality and content because he never saw the main menu page. If Telemed15 and Telemed23 just wanted to test their hearing they may have decided to go straight to the external site – making the DBCI redundant – and leading to digital disengagement. However, the fact that these participants never gained access to the rest of the intervention means that it is impossible to state how they would have used it or whether they would have used it differently if they had seen the rest of the content. It is therefore worth considering how the design of the DBCI could be altered to prevent this access issue or at least inform the users of the additional content available after the questionnaire.

There are a number of ways to inform the user of their location in the system or the content that is to come. Designers can use navigational tools – such as breadcrumbs or progress trackers – to show the participant where they are in the system or how many pages there are left to completion. Furthermore, designers can also simply provide this information in written text at the start of the process – so that users know what to expect (setting the users' expectations).

However, another consideration is the design and flow of the intervention. This architectural design – known as a tunnelling (Danaher *et al.*, 2015, p.97) – guides a user through a series of pages, in this case the questionnaire. This method is very useful when a researcher wants to ensure certain pages are seen and completed. However, hiding part of the intervention from the user may have led to confusion or frustration and ultimately to their disengagement. Unfortunately – without additional qualitative data – this usage data cannot explain why these participants did not complete this page flow. One possibility is that they did not see any benefit to returning to the system to input their test results. Researchers therefore might want to provide incentives to encourage users to return to the system to track their results.

These different design choices can help inform the user, set their expectations, and ensure that they do not miss parts of the intervention unnecessarily.

9.3.2.2 Disinterest?

Telemed9 (the '*dropout*') reported login issues and a desire for 'face to face contact' as the reasons for leaving the study and digitally disengaging. However, according to the data she only attempted to log in twice; the first time she did not complete the questionnaire in full and the second time she successfully reached the main menu page (see Figure 9.11). She spent 15 seconds on the menu screen and then logged out. In this time she probably read the menu options, but without additional data – such as eye tracking – this cannot be confirmed. Telemed9 did not return to the DBCI after

this session. It is possible that she was disinterested in the DBCI content and that this led to her digital disengagement. Without additional data – such as her opinion of the content – it is impossible to confirm this hypothesis.

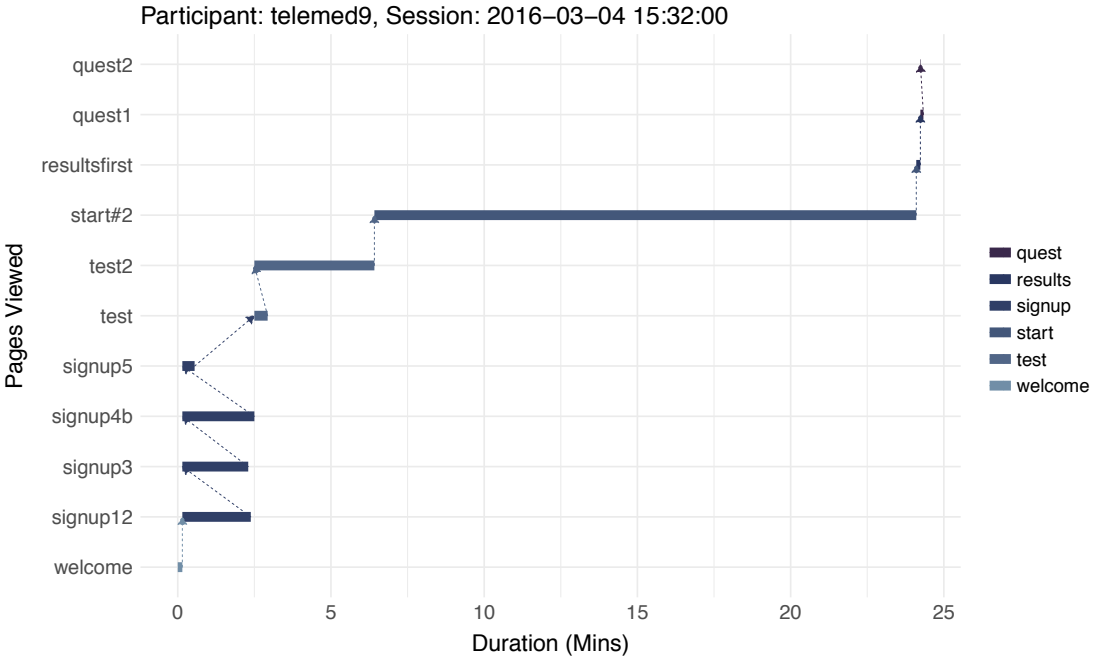

Figure 9.11: Page flow graph of Telemed9's session 1

Telemed30's one session may also suggest disinterest in the intervention *content* or *functionality*. After successfully completing the questionnaire she browsed one area of the site (the practice content from the rehab section) then quit the intervention and did not return (see Appendix E Figure E.3). Telemed22 also may have digitally disengaged due to disinterest. The majority of his first session was spent registering but he had a look at a few pages. His second session (12 mins long) was spent exploring various different pages and then he did not return again. It is possible that he discovered what he needed to from this session and did not have a reason to return.

Telemed9, Telemed22, and Telemed30 had similar patterns of usage. They all explored a limited amount of the DBCI before deciding to digitally disengage. It would be interesting to explore this further to understand whether the content did not meet their expectations or whether they disengaged for another reason. For example, participants may not engage with this DBCI because their cochlear implant was working well and they have no need to alter it or seek support. However, without additional qualitative data it is impossible to know.

Intervention designers may want to include a site map or traditional navigation menu bar to provide an overview to the users of the type of content on offer. The main menu page does not provide very much information about the different areas of the site and it appears that some users may be basing their judgements of the DBCI on this page.

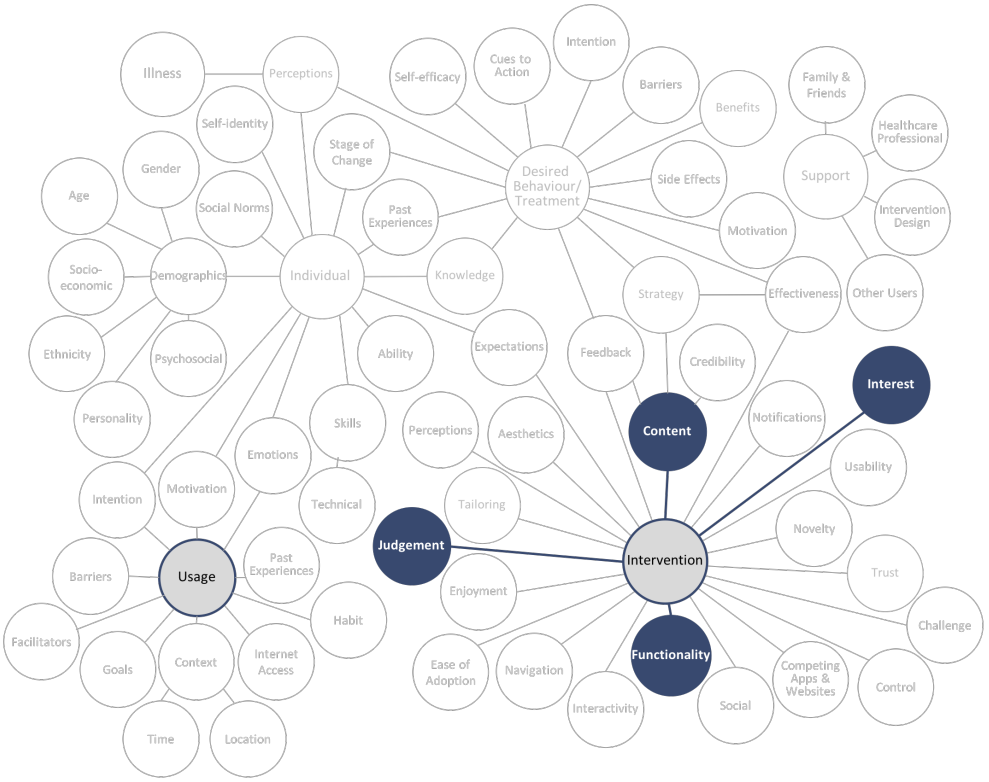

Figure 9.12: The DisENGAGE Framework highlighting the factors relating to the content of the CIRCA DBCI

9.3.2.3 Usability Issues

Telemed9 officially dropped out of the study stating problems 'checking in on the computer' (Cullington, 2016, p.16). Investigating Telemed9's login attempts did highlight a number of other participants that seemed to struggle with this issue.

Telemed1 spent a noticeable proportion of each session logging in (see Figure 9.13). Telemed42 also struggled, spending over 15 minutes trying to log in during her third session (see Figure 9.14). After this session she logged in two more times spending less than a minute on each session. It is unclear whether these issues were caused by human error or whether there was an issue with the login function of the intervention.

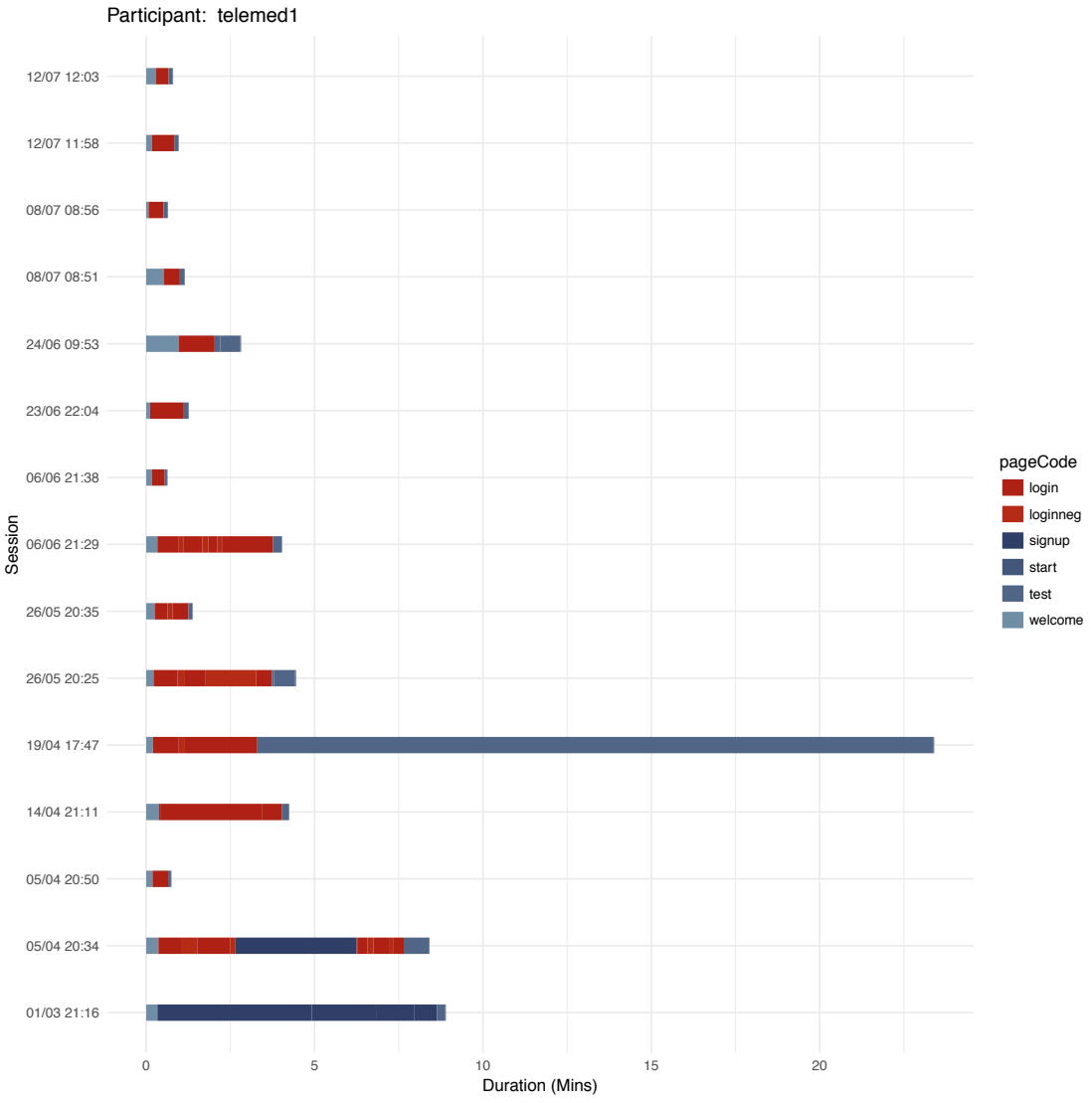

Figure 9.13: Page flow graph of Telemed1's sessions

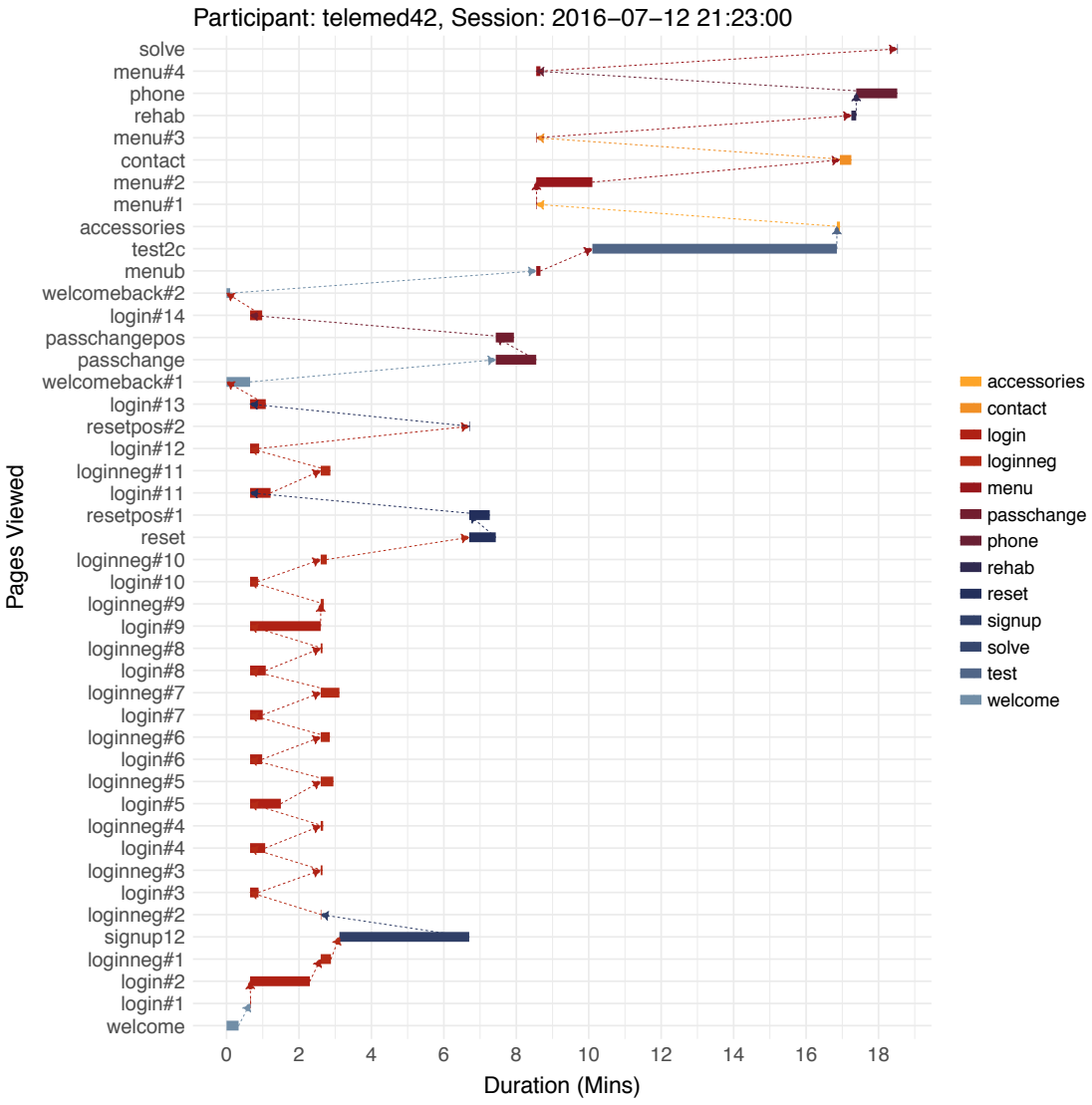

Figure 9.14: Page flow graph of Telemed42's 3rd Session

This issue also affected Telemed10, but this did not seem to affect her desire to use the DBCI. She spent nearly 35 minutes attempting to log in during her fourth session (see Appendix E Figure E.4). She had over 8 failed attempts.

Login problems can evoke strong negative feelings – such as frustration or anger – in the user (Lazar *et al.*, 2003), which can easily lead to disengagement (see Figure 9.15). It is therefore important that researchers identify these issues and remove them as soon as possible.

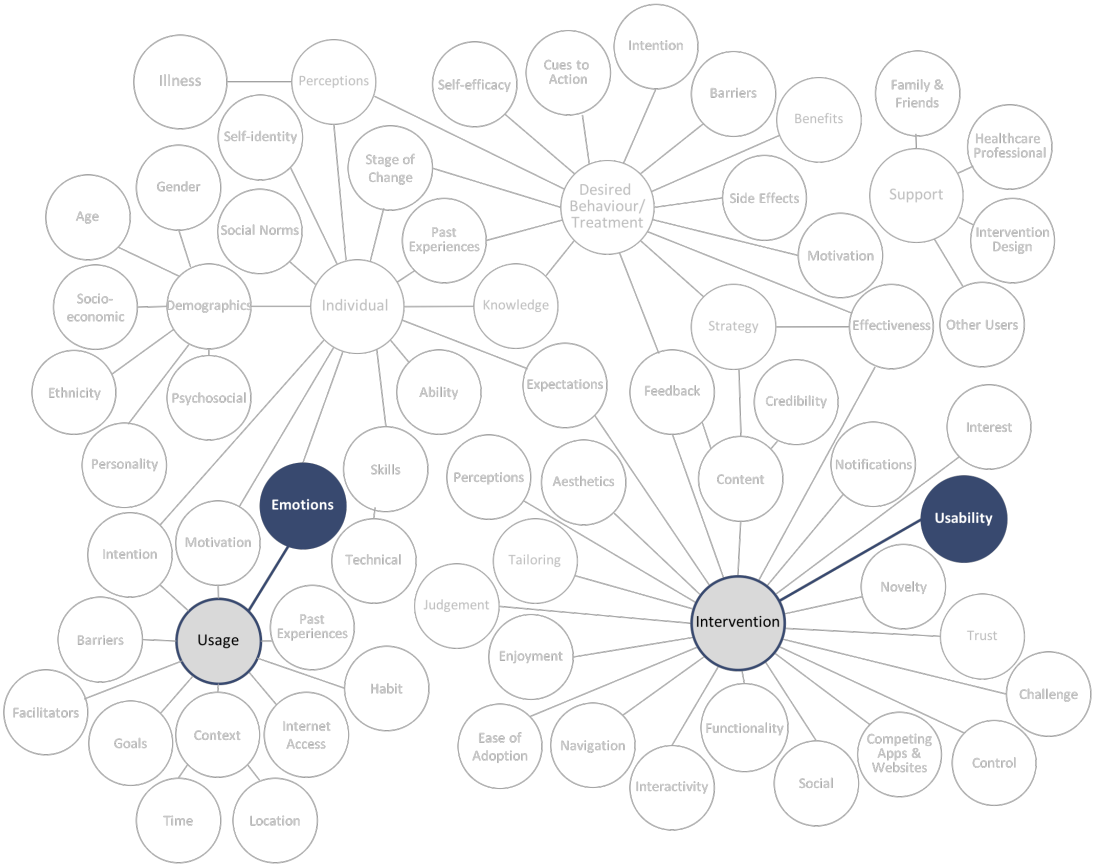

Figure 9.15: The DisENGAGE Framework highlighting the factors relating to the usability of the CIRCA DBCI

9.3.2.4 Notifications

LifeGuide has the functionality to send notifications – either emails or SMS messages – to participants. These messages are initiated when the user passes a trigger page, by clicking on to the next page (Williams *et al.*, 2010b, p.117). Messages are not sent immediately but delayed by a number of seconds, which is pre-set by the designer. In addition, each message is assigned a unique name which allows the system to cancel emails that have not yet been set. This is a useful feature if designers want to trigger

multiple emails based on certain criteria and then cancel these if particular conditions change.

Unfortunately, the system does not track sent messages. Instead, this has to be calculated by working out which trigger pages were passed and whether the cancellation criteria for each message would have been triggered. These calculations can be used to add an additional layer to the login graph. However, this type of graph can only hypothesise when a participant may have been sent a message. This does not necessarily mean the participant opened the message at this point in time.

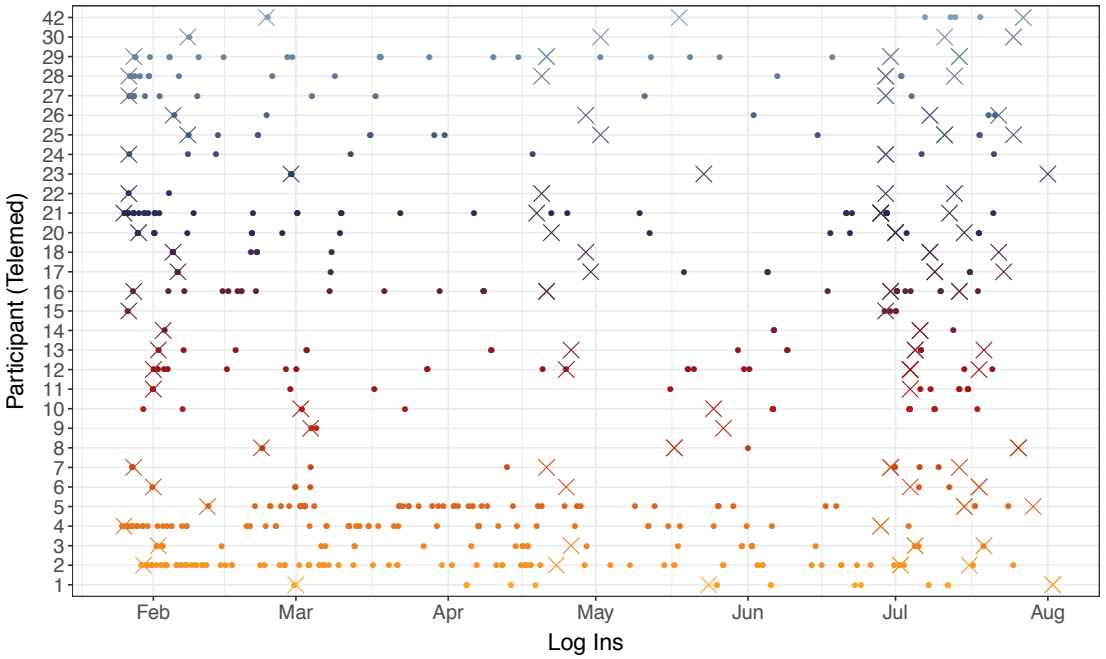

Figure 9.16: A graph showing the login and notification points (X) for each CIRCA participant over the six month period

Figure 9.16 is an adapted version of the original login graph, where the crosses show when a notification may have been sent to the participant. Although this is an estimation it does highlight some interesting response patterns. Every user was sent an email after their first session. However, the graph shows that a number of participants – such as Telemed14 and Telemed15 – did not give permission to receive multiple emails between sessions. Furthermore, Telemed15's return to the system after 5 months seems to have been prompted by a notification from the system. A number of other participants – such as Telemed3, Telemed7, and Telemed16 – seem to have logged in after receiving an email. These participants may have just logged in to complete the follow-up questionnaire or the notification may have reminded them of the DBCI.

Understanding the motivation of each participant for logging in to the system can help to inform future DBCI development (see Figure 9.17). If users had forgotten about this DBCI a regular reminder email might help to support the self-management of their hearing and cochlear implants.

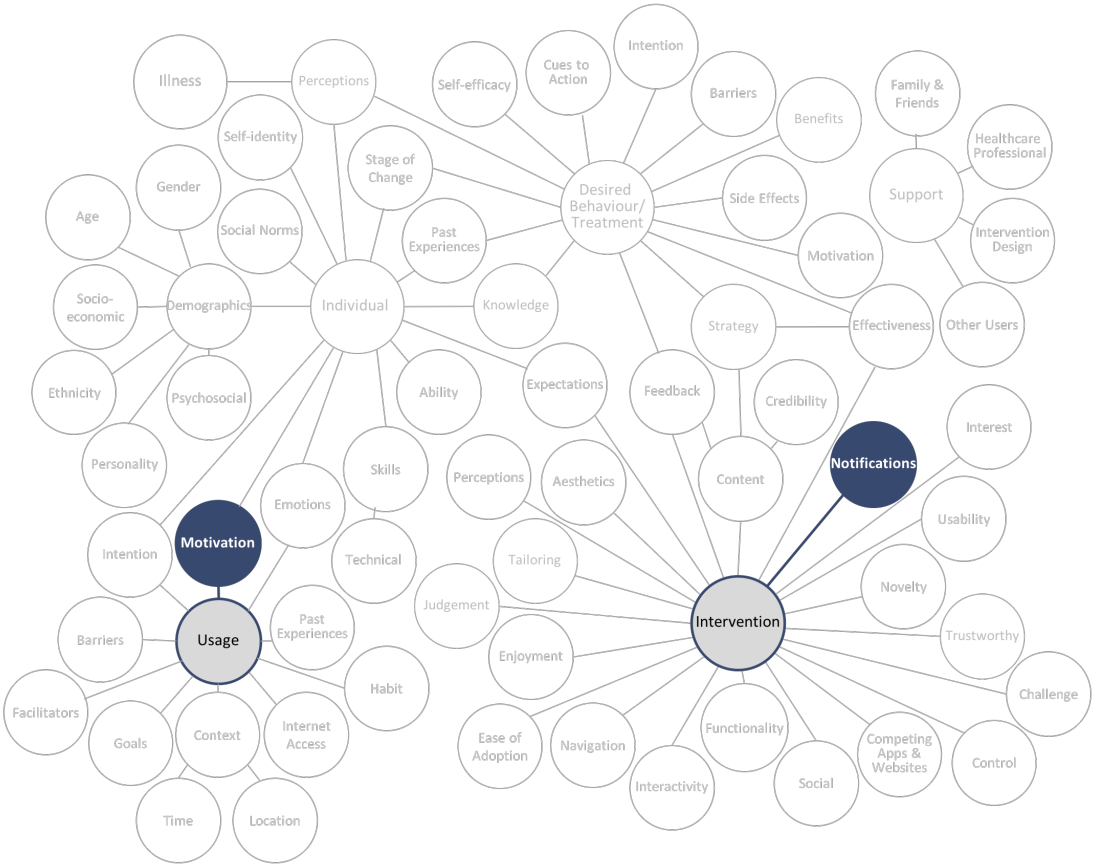

Figure 9.17: The DisENGAGE Framework highlighting the factors relating to the notifications from the CIRCA DBCI

9.3.3 Summary: Disengagement Analysis

This disengagement analysis identified a number of interesting usage patterns. Several users – Telemed1, Telemed15, and Telemed23 – did not pass the compulsory questionnaire and therefore never accessed the main DBCI content. It is unclear whether these participants were only interested in the hearing test function or whether they were unaware of the rest of the intervention content. Designers may wish to consider ways – through the DBCI design – to inform the participants about the other areas of the intervention.

Telemed9 (the '*dropout*'), Telemed22, and Telemed30 viewed a small section of the DBCI and then did not return. This may signify that they were disinterested in the content or the functionality of CIRCA. Alternatively, they may not have returned because they did not feel a need to do so. Without additional data it is impossible to draw a conclusion about this.

Several participants – Telemed1, Telemed10, and Telemed42 – seem to have struggled with the login functionality. This type of usability issue can easily lead to frustration

and disengagement. Therefore this type of issue should be addressed by the intervention developers.

Finally it seems that a number of users were prompted to log in by a system notification. Some of these participants – such as Telemed15 – had not used the system for a significant period and potentially had forgotten about it. It appears that these notifications therefore re-engaged some of the users and this could be explored in future DBCI studies.

9.4 Summary

This chapter has explored a small-scale intervention called Cochlear Implant Remote CAre (CIRCA); aiming to support recipients of cochlear implants. The original study found: an increase in levels of empowerment using the CI-EMP; that hearing levels had stabilised in the intervention group; and that patients were keen to continue using the DBCI. Cullington *et al.* (2016) had also reported a low rate of dropout – 2% – in the original study and this was explored in the disengagement analysis.

This analysis utilised the DisENGAGE Framework to explore and explain a number of interesting usage patterns. It identified a number of barriers which prevented certain participants from progressing through the DBCI. For example, the incomplete questionnaire prohibited participants from seeing the main intervention content. Although there were a number of potential explanations for why the users did not complete the questionnaire, this analysis still identified this clear barrier to usage.

There were a number of potential explanations for the different usage patterns, such as disinterest in the content, login issues, and notifications. However, without additional data it was impossible to confirm or disprove the various hypotheses. This research did highlight that the *official* dropout rate of 2% may not accurately represent the usage of the DBCI or the experience of the CIRCA users.

This issue of incomplete data also limited the analysis of PRIMIT in the previous chapter. Collecting qualitative data – in addition to usage data – would lead to a more comprehensive understanding of intervention usage. This will be explored in the next chapter using the Getting Active case study. However, without any additional data, this analysis has still identified a number of actionable steps that can reduce the barriers to usage and thereby reduce digital disengagement.

Chapter 10

Case Study 3: Getting Active and the DisENGAGE Framework

Chapter 9 analysed various interesting usage patterns from the CIRCA study. However, the lack of qualitative data to contextualise the usage data limited the disengagement analysis. This chapter focuses on exploring disengagement from the Getting Active intervention. It also addresses the remaining research aims:

RA3 Investigate how qualitative and quantitative (usage) data can be used to understand disengagement using the framework

RA4 Demonstrate how the theoretical framework can guide researchers through the process of disengagement research, including planning for, collection of, and analysing disengagement data

This chapter presents a different type of case study because the disengagement research was conducted alongside the original research objectives. The DisENGAGE Framework guided the planning, collection, and analysis of the disengagement data (RA4). A mixed methods approach provided the qualitative and quantitative (usage) data required for in-depth analysis. This data was investigated using the DisENGAGE Framework (RA3) which explored disengagement from the DBCI.

The analysis moves away from the previous two case studies, which aimed to identify participants who had disengaged and the factors that led to this. Instead, the Getting Active analysis looks to identify the factors that can predict participants who are likely to disengage and the interlinked factors that can lead to this disengagement. This would help to identify future participants that are likely to disengage, and by addressing the recommendations set out in this chapter the likelihood of this disengagement can be reduced.

Section 10.1 introduces the original study, its context, and objectives. Section 10.2 provides a brief overview of the intervention, its contents and some example screenshots. Section 10.3 explains the disengagement research study, including recruitment, the stages of the research, and the methods of qualitative data analysis. Using the DisENGAGE Framework, Section 10.4 analyses various different aspects of the Getting Active data. It incorporates the think-aloud and retrospective usage stage of the study to explore different disengagement factors. Each factor is analysed in the context of the framework to better understand the reasons for disengagement, including related framework factors. Section 10.4.4 presents the methodological considerations of this data collection and analysis.

10.1 The Original Study

The Getting Active DBCI is a module that will be combined with other modules to form a larger DBCI called 'My Breathing Matters'. This DBCI will provide information about common asthma-related concerns, an action planning tool, medication adherence challenges, breathing training, information for friends and family, and tools to manage stress and anxiety (Ainsworth *et al.*, 2016). 'My Breathing Matters' is being funded by a larger research programme called 'Integrating Digital Interventions into Patient Self-Management Support' (DIPSS) (Yardley *et al.*, 2013). However, the Getting Active DBCI is a stand-alone module that aims to help asthma sufferers increase their activity levels. This case study explores disengagement from the Getting Active DBCI.

10.2 The Intervention

The Getting Active intervention utilised the tailoring feature offered by LifeGuide, which allows a designer to specify the pathway through a site. The CIRCA intervention – Chapter 9 – used this feature to make the questionnaire compulsory. Getting Active used this feature to lock certain sections of the site until users had reached a certain page. Figure 10.1 shows the flow through the sections which unlocked the pages. The following sections explain the areas of the Getting Active intervention in the order that they would have been unlocked, during the first session.

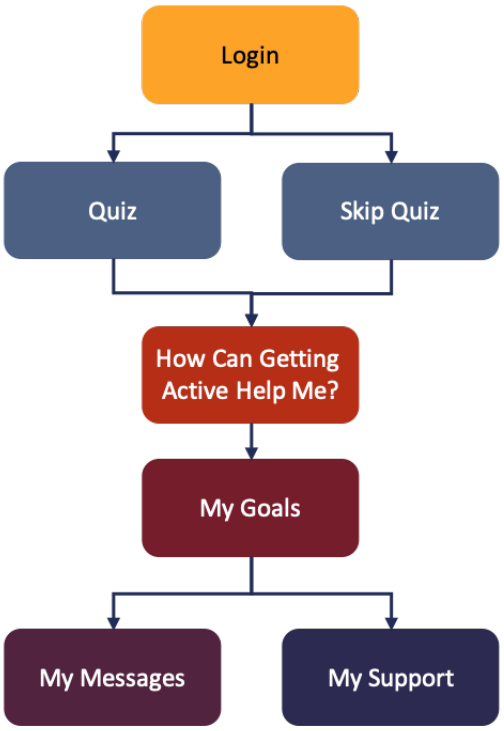

Figure 10.1: A page flow diagram to show how to unlock areas of the Getting Active DBCI

10.2.1 'Quiz'

The quiz was a series of five true and false statements which introduced the asthma topic (see Figure 10.2):

1. Physical activity is safe for people with asthma.
2. Spending less time sitting down can improve your health and your mood.
3. A regular walk to the shops, the bus or the park can improve your appearance.
4. Getting active can improve my breathing.
5. Being active is good for my overall health.

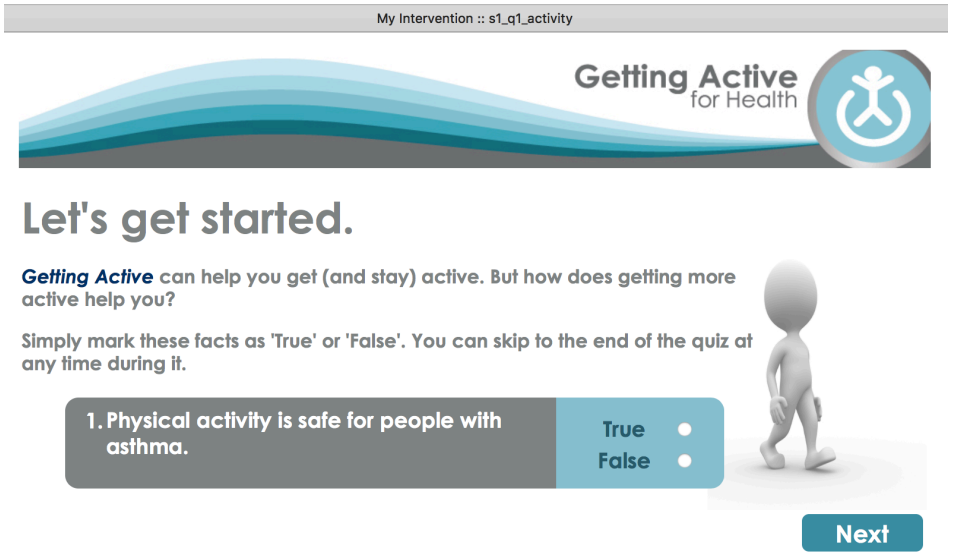

Figure 10.2: Getting Active 'Quiz' page

Each statement was followed by a feedback page, which explained whether the user was correct (see Figure 10.3) or incorrect (see Figure 10.4); it also provided further information about each of the statements. Participants were guided to the quiz on their first visit. However, it could be skipped and returned to later from the homepage. Once the user had completed or skipped the quiz, they passed to the 'How can getting active help me?' section.

Figure 10.3: Getting Active 'Great!' quiz page

Figure 10.4: Getting Active 'Surprise!' quiz page

10.2.2 'How Can Getting Active Help Me?'

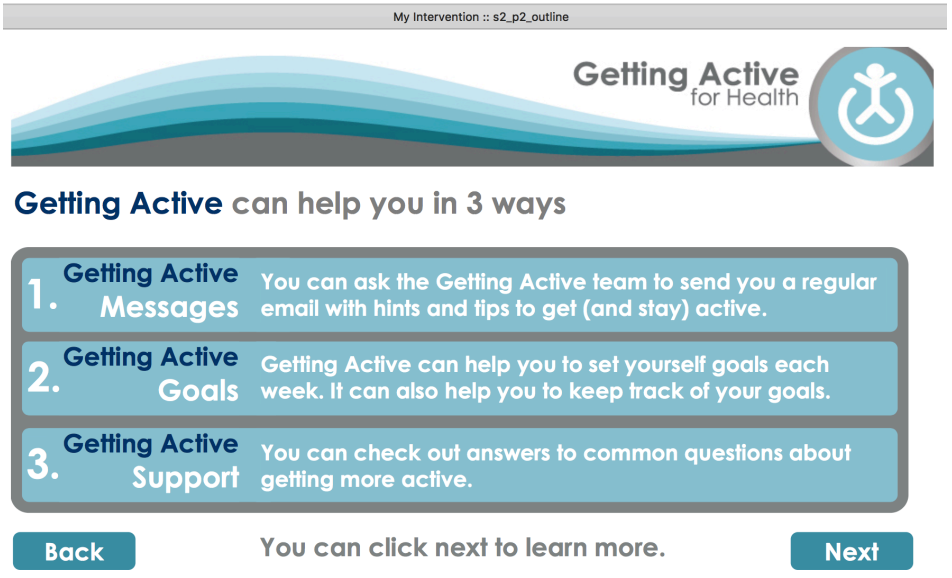

Figure 10.5: Getting Active 'How can getting active help me?' page

The 'How can getting active help me?' section explained to the user the three main areas of the intervention - 'My Messages', 'My Goals', and 'My Support' (see Figure 10.5). This step-by-step sequence guided individuals through setting up their emails. Users were able to set the frequency of messages, which included the option to opt out.

These pages also explained how the goals and support features worked. At the end of this process users were shown the homepage with 'My Messages' and 'My Support' links locked – greyed out (see Figure 10.6). These sections were unlocked once the user had passed through the 'My Goals' section.

Figure 10.6: Getting Active 'Homepage' showing locked sections

10.2.3 'My Goals'

The 'My Goals' section introduced the idea of setting a weekly activity goal to encourage the user to be more active. The DBCI then guided the user through a series of pages, helping them to set their goals (see Figure 10.7). The introductory screen explained that goals should be personalised to suit their needs and that it was a good idea to start with an easy goal which increases in difficulty over time. The following sections explain these stages in a bit more depth.

Figure 10.7: A page flow diagram to show how the 'My Goals' section of the Getting Active intervention was structured

10.2.3.1 'Ways to Get More Active'

Users were shown a 'Ways to get more active' page which presented six different activity ideas. This aimed to provide some inspiration for the individual during their goal setting process (see Figure 10.8). When the user clicked one of the activities – such as 'Walking' – they were shown some suggestions (or ideas) about how to include this activity into their week and a tab (link) to a success story (see Figure 10.9).

Each suggested activity follows this template of ideas and success stories. The 'Success story' tab contains a short account or quote – from what appears to be a real person – which explained how they had incorporated that activity into their life. However, no identification or source was provided for these quotes.

The one difference with the 'Walking' page was that it contained a link to find out more information about a free pedometer, which was offered (upon request). The page explained that pedometers are a good way of tracking daily steps and that people are more likely to walk further when they wear one.

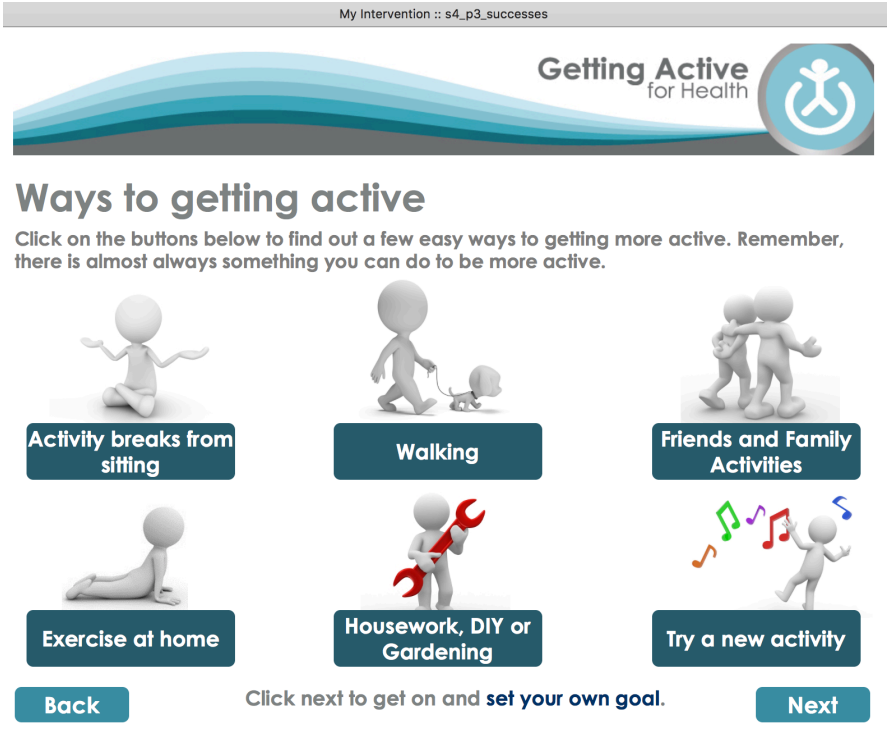

Figure 10.8: Getting Active 'Ways to getting active' page

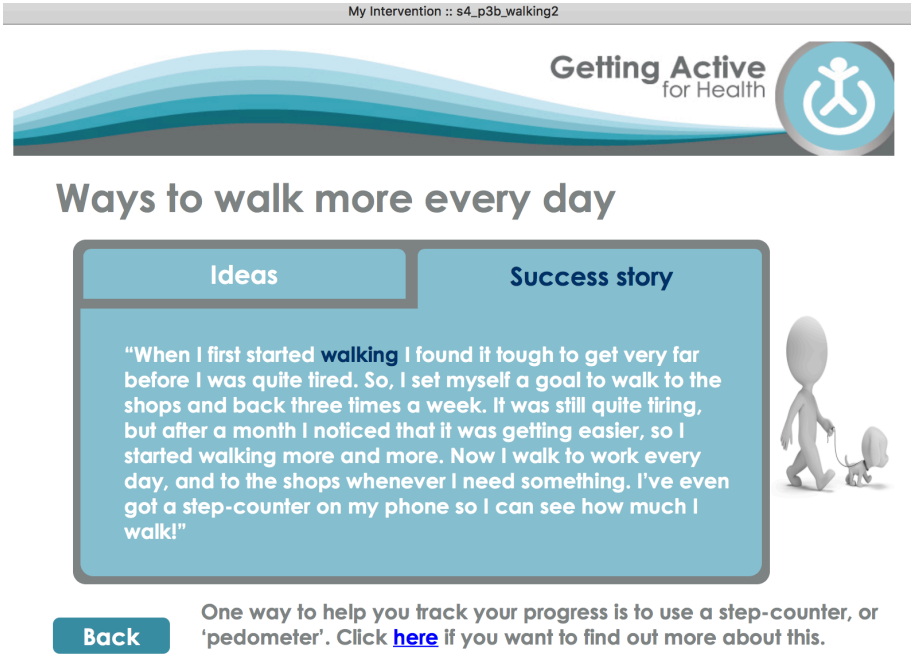

Figure 10.9: Getting Active 'Ways to walk more everyday' page

10.2.3.2 'Setting your Activity Goals'

After looking at the different activity options, a user was directed to another introductory screen about goal setting. This page prepared users to set their goals, focusing on two main questions:

1. How hard will it be to achieve my goal?
2. Can I achieve my goal in around a week?

Individuals were then guided through the process of setting goals. First, they selected how many goals they wanted for that week – one, two, or three. Second, they were asked to set a specific goal, either from the drop down list, which included 'Walking', 'Housework/DIY', 'Family/Friends activity', or 'Home exercises', or there was a free text field where they could type in their own activity. Third, the user set how many days that week they wanted to carry out the activity. The final screen showed the goals for that week including the number of days. The DBCI also offered a print out for the participants to have a copy of their personalised 'Activity Plan'. Once users had set their goal they were shown a completion page which explained that the 'My Support' and 'My Message' areas of the site had been unlocked.

10.2.4 'My Support'

The 'My Support' section of the site offered information about safety – including other symptoms and other health conditions – as well as ideas around motivation, overcoming setbacks and seeking support from friends and family.

10.2.4.1 'How Safe is Getting Active?'

The safety section listed a number of health conditions:

1. Asthma
2. Diabetes
3. Heart Disease
4. Kidney Disease
5. Joint Pain
6. Dizziness

These pages explained if and how these conditions might impact the user's activity goals but also how to overcome these concerns and – more fundamentally – why it was still good to get active. There was also a link to follow if their condition was not listed. This directed the user to an information page which encouraged them to check their plans with a doctor. However, it also reassured individuals that it was rare for a health

condition to prevent *all* types of activity and that it might just be a case of finding an activity that was appropriate for them.

There was also a symptom section which included:

1. Feeling hot
2. Sweating
3. Out of breath
4. Heart pounding
5. Joint pain
6. Tight chest

There was also a link for unlisted symptoms, which encouraged the individual to visit a doctor if they were concerned. Following a similar template to the health conditions pages, these symptom pages offered a brief explanation of why this symptom might be occurring and then provided helpful hints to try and alleviate the symptoms.

10.2.4.2 'My Getting Active Support'

This part of the site explored various topics surrounding support including:

1. Getting friends and family involved
2. Using a step counter
3. Overcoming setbacks
4. Tips to stay motivated

The 'Getting friends and family involved' pages encouraged individuals to ask friends and family to join in with the activities or to simply ask for support during their behaviour change attempt (see Figure 10.10). Individuals were also encouraged to use social media to let others know what they had achieved. There were also a number of success stories to motivate the users.

The 'Using a step counter' section directed the user to the same type of page that they would have seen during the goal setting section. However, this page had an additional link to information about how to use the step-counter and ways that other individuals had used the device. The 'Overcoming setbacks' section challenged individuals to consider why they had faced setbacks. It also encouraged them to consider how they could do things differently in the future to prevent additional obstacles. The 'Tips to stay motivated' section emphasised the importance of setting goals and exploring motivations for being more active. These sections also contained a number of success stories (see Figure 10.11).

Figure 10.10: Getting Active 'Getting friends and family involved' page

Figure 10.11: Getting Active 'Overcoming Setbacks' page

10.2.5 'My Messages'

The 'My Messages' section was fairly straightforward as the individuals were guided through the set up of their messages at the start of their usage (during the 'How can getting active help me?' guide). However, it also showed users how they could change the frequency of their messages and troubleshoot why they weren't receiving messages. The troubleshooting section displayed the user's email address so that this could be verified, advised users to check their junk folder for messages, and displayed the frequency of emails they had asked to receive each month. There was also a success story link which explained to users how simple it was to cancel these messages and how useful other people had found the messages to be.

10.2.6 'Helpful Links'

The final section of the website contained three tabs which each offered a number of external links for help and support:

1. Asthma UK
2. General Advice
3. Local Activities

The 'Asthma UK'[1] site offered a range of information from health advice to ways of getting involved with the organisation. The 'General Advice' offered external links to advice about exercise, gardening, and adventure sports. Finally, the 'Local Activities' tab linked to 'Change4Life'[2], 'WalkingforHealth'[3], and 'UK Men's Shed Association'[4] to find places to do DIY and other practical activities.

10.3 The Disengagement Study Design

Case studies 1 and 2 involved retrospective analysis of usage data and as a result the exploration of disengagement was limited. Data was not specifically collected to explore disengagement and therefore these studies did not benefit from the mixed methods approach, specifically methodological triangulation. This disengagement study was conducted in collaboration with the original researchers allowing targeted data collection and analysis.

There were two phases to this case study; stage one involved six participants who took part in think-aloud sessions, and stage two involved an additional 13 participants who

[1] https://www.asthma.org.uk
[2] https://www.nhs.uk/change4life-beta/activities
[3] https://www.walkingforhealth.org.uk
[4] http://menssheds.org.uk

were interviewed after a two week usage period. This research followed a multi-phase approach collecting think-aloud data (QUALITATIVE), usage data (QUANTITATIVE), and retrospective interview data (QUALITATIVE) (see the sequencing process explained in Section 7.1.3). The following sections explain the disengagement study design.

10.3.1 Recruitment

There are many considerations for recruitment sampling, such as the type ('representative' or 'exploratory'), and approach (such as 'probability' or 'non-probability'). Recruitment depends upon the research study and objectives. 'Representative' samples aim to reflect the the target population and are mainly used in large-scale studies; whereas 'exploratory' samples are used in smaller studies to generate new ideas about a topic (Denscombe, 2014, p.32-33).

'Probability' sampling is considered the best way of collecting a random unbiased sample. 'Non-probability' sampling uses certain selection criteria and is used when the make-up of a research population is unknown, when a large scale project is infeasible, or when it would be difficult to recruit participants through a probability sampling technique (Denscombe, 2014, p.33).

Recruitment for DBCI studies is limited by their use of specific methods and target population. The selection of certain methods within the research design will affect the appropriateness of a sampling technique. For example, Getting Active utilised think-alouds and interviews which are impracticable and counterproductive when done on a large scale. Instead, these require a smaller 'exploratory' sample that can provide rich in-depth data for analysis. However, some DBCI research may want to explore disengagement on a wider scale, utilising methods such as large-scale questionnaires and usage data. Questionnaires can be sent out to a large volume of participants and therefore researchers may desire a representative sample for this type of study.

In addition, DBCIs often target particular behaviours or illnesses, which would require a 'non-probability' sampling approach. For example, the Getting Active DBCI was designed for asthmatics who wanted to increase their physical activity. Participants were therefore recruited in a number of ways, using a mixture of sampling methods. All recruitment followed a 'purposive' sampling method, selecting participants for their *relevance* to the DBCI and *knowledge* of asthma (Denscombe, 2014, p.41). Furthermore, all participants had to be over 18.

The think-aloud participants were recruited through their local GP surgery following an 'opportunistic' sampling technique, which takes advantage of recruitment opportunities as they arise (Palinkas *et al.*, 2015, p.536). The retrospective usage participants were recruited through social media channels and adverts around the University of Southampton. This utilised a 'convenience' sampling method – for example, participants who

were most likely to respond, were geographically close, or were easy to recruit (Bowling, 2014, p.209). However, the sampling methods do not produce a representative sample and therefore this means the research findings are less generalisable. However, disengagement is an individual experience and is unique to that specific DBCI. Therefore the aim of disengagement research is not to generate broad statements about why users disengage from DBCI but rather to better understand the target population for a specific DBCI. This in-depth data allows researchers to explore the DBCI design and address any barriers to usage.

Participants were also given a £10 gift voucher to reimburse them for their time. There are differing opinions in the research community about the use of monetary incentives but it has been found to increase participation (Head, 2009). Although this incentive may have encouraged individuals to participate in the study they were each given the full amount regardless of their performance. This was included in the ethics applications for each stage of the study. Additionally, informed consent was obtained from each individual and as part of this process, participants were told that they could leave the study at any point.

10.3.2 Stage 1: Think-alouds

Think-aloud interviews are part of the 'Early Development' stage of the 'Person-Based Approach' (Yardley *et al.*, 2015). A think-aloud involves an individual using a system and verbalising their thought processes, either during or after a particular task (Wilkinson *et al.*, 2004, p.54). This type of data collection investigates the user's response to each component of the prototype, exploring whether they find it enjoyable, interesting, acceptable, and easy to use (Yardley *et al.*, 2015). In addition to providing this feedback for the intervention design it also provides data for the disengagement research.

The think-aloud study helped to develop the intervention and gather initial indications of interesting disengagement factors. Six participants – two males and four females – were asked to take part and it was conducted over a three-month period. Participants ranged in age from 24 to 45 with all but one either living with a partner or married (see Appendix F Table F.1).

It was conducted in a place of the participant's choosing, either a room on the University campus or at their home. Participants were given the choice of setting so that they could choose the location where they would feel most comfortable. These two locations present different usage settings for the participants. The University room could be set up with the researcher controlling the environment; for example limiting noise and other interruptions – like a laboratory setting (Dix *et al.*, 2004, p.328). However, this less natural setting can reduce the validity of the collected data (Nørgaard & Hornbæk, 2006). The home setting is more natural, although background noise can reduce the

quality of the recorded data. Furthermore, participants in both cases are still aware that they are being observed and recorded as part of the study, and therefore still may not act naturally (Dix *et al.*, 2004, p.328).

The think-aloud studies did not aim to replicate real-world usage but rather identify design issues and potential disengagement factors (from the DisENGAGE Framework) that could be explored in the two-week usage period and retrospective interviews.

Before starting the think-aloud interviews, my colleague (AM) asked the participants for some background contextual information. Each participant was asked to discuss their asthma condition, how it made them feel, the age that they were diagnosed, the support they had received, and their current activity levels. AM then asked participants to describe the process of walking through two rooms in their house. This was to show the participant the level of detail required for the think-aloud process (see Appendix F.1 for the full think-aloud interview guide). During the think-aloud AM did not respond to questions, but did use prompts when the participant forgot to think-aloud or if they were particularly quiet.

Often think-aloud interviews follow a 'test protocol' which lists particular tasks or asks for opinions on certain aspects of the design (Reiss, 2012). However, think-alouds can therefore be criticised for simply confirming pre-known usability issues (Nørgaard & Hornbæk, 2006). The Getting Active think-aloud did not set the users particular tasks but instead asked individuals to explore the intervention as *naturally* as possible. This reduces the likelihood of the participant being led towards particular issues but also produces the most natural experience of a user exploring a new system, helping to identify early digital disengagement factors.

This think-aloud data was thematically analysed following the 'Framework Method', utilising the DisENGAGE Framework (see Section 10.3.4). As a result of this analysis several factors were identified that seemed to indicate potential disengagement, including various aspects of the UX. These were explored in more depth during the second stage (retrospective usage analysis). This data provided an insight into how participants first perceived the intervention and how they found the initial experience of use.

10.3.3 Stage 2: Retrospective Stage

Stage 2 involved 13 participants – four males and nine females – who were between 22 and 77 years of age (see Appendix F Table F.2). The following sections explain the different data collection methods used in this stage.

10.3.3.1 Usage Data

The think-aloud studies provide data about a user's initial reaction to the DBCI and experience of use. However, this data cannot show how or why a user adopts a DBCI in their real life or how usage is impacted by their behaviour change attempt. For this reason, participants were asked to use the intervention – as naturally as possible – for a minimum of two weeks. This usage analysis followed the process set out in Section 7.3.4, utilising the LifeGuide exports.

The generated graphs provided insights into the individual's specific usage pattern, including the length of a session, pages views, and time spent on each page. It also provided insights into factors that affect real-world adoption, and digital disengagement. The usage analysis and think-aloud data were explored using the DisENGAGE Framework. The framework helped identify the various factors that were investigated in more depth in the interviews. This analysis generated a set of tailored questions for specific users, in order to further contextualise their usage data.

10.3.3.2 Interviews

Following their usage period, participants were invited to interview, either face-to-face, on the phone, or via Skype. An interview allows a participant to verbalise their thoughts in their own words and encourages them to narrate their experience. This process often highlights their reactions and sometimes unconscious motives (Wilkinson *et al.*, 2004, p.42).

The Getting Active study combined two types of interview: 'retrospective' and 'semi-structured'. 'Retrospective' interviews are conducted after a set activity – the two week usage period – and enable a researcher to check their understanding of the collected usage data (Rogers *et al.*, 2011, p.237). However, these interviews also aimed to explore behavioural disengagement, not just contextualise usage data.

'Semi-structured' interviews broadly follow an interview guide; all the questions are asked but additional questions and prompts can be used depending on the interviewee's responses (Bryman, 2012, p.471). This is particularly relevant for the Getting Active study because the DisENGAGE Framework aims to guide research but encourages researchers to respond to the specific experience of the individual. For this reason, it would not have been useful to follow a structured interview process (following a set list of questions) because important disengagement factors may be missed and remain unexplored.

Semi-structured interviews use an interview guide which evolves throughout the data collection (Bryman, 2012, p.476). As disengagement factors emerged, the Getting Active

guide evolved to explore these themes with the subsequent participants. The guide (see Appendix F.2) also followed the recommendations set out by Bryman (2012, p.473):

1. Order questions (roughly) by topic so that they flow easily but be prepared to alter the order during the actual interview.
2. Questions should address your research questions (but they should not be too specific).
3. Language should be appropriate for the participant being interviewed.
4. Do not ask leading questions.
5. Record 'facesheet' information such as demographic and other relevant contextual information.

The order of questions is important and for this reason questions relating to the individual's usage of the DBCI were saved until the end of the interview. This was to try and minimise the 'Hawthorne effect' – a change in participant's behaviour due to their awareness of being observed (Bowling, 2014, p.376). Reminding a participant that their usage was logged and had been analysed may have affected their responses. Asking these questions at the end of the interview attempted to limit this effect. Questions were carefully worded to avoid judgement, so rather than asking why they missed Section X, questions were asked about Section X to encourage discussion around this topic.

In addition to the interview questions, good rapport between interviewer and interviewee is crucial during data collection and requires the individual to be comfortable in the study environment and to trust their interviewer (DiCicco-Bloom & Crabtree, 2006, p.316). Some argue that a researcher should remain neutral and passive to avoid creating a negative dynamic between the researcher and participant (Denscombe, 2014, p.191). However, this can create an unnatural setting which can unsettle the participant and may not lead to the required rapport. Disengagement research requires a particularly strong rapport between the interviewer and interviewee because the interviewee may need to communicate negative feelings or comments about the DBCI experience and needs to feel comfortable to do so. Getting Active interviews were therefore mainly conducted via Skype to encourage a more conversational tone, aiming to relax and empower the participant (Denscombe, 2014, p.191).

A good interviewer also needs to be sensitive to the participant's feelings, respect silences, and be skilled at using prompts and probes (Denscombe, 2014, p.192). As this was the first time I had interviewed for research, I practised these skills during a trial interview with my supervisor MS.

Researchers also need to consider the impact of 'demand characteristics' – cues within the study that make the participant aware of the expectations or hopes of the researcher (Nichols & Maner, 2008, p.151). The study design – asking participants to use the DBCI for two weeks – indicated to the individual that they would need to report on

their experience of usage. They were aware that the DBCI had been developed in-house and therefore might have been inclined to exaggerate the positive attributes and ignore the negative. Disengagement research needs individuals to be honest about their experience (the positive *and* the negative) and therefore in order to eliminate this potential for a positive bias, participants were informed that I personally had not designed the intervention. The participants were encouraged therefore to be honest in their feedback and I emphasised that I would not be offended by anything they said. This interview data was thematically analysed and then combined with the usage analysis to explore and develop a holistic understanding of the individual DBCI experience.

10.3.4 Thematic Analysis

The think-aloud data and retrospective interview data was analysed using a 'Thematic Analysis' approach. This approach helps researchers generate themes and meaning from qualitative data.

'Themes' or coding categories can either be generated from the data itself – an 'inductive' approach – or from pre-existing domain knowledge and theories – a 'deductive' approach (Joffe & Yardley, 2004, p.57). The choice regarding whether to follow an inductive or deductive approach relates to the research question (Braun & Clarke, 2006, p.84). A researcher wanting to answer specific research questions is more likely to follow a deductive approach whereas a researcher investigating a new idea might follow an inductive approach, to ensure they do not miss vital aspects of a phenomenon. It is also possible to use a combined approach which allows the exploration of particular research topics but also leaves the analysis open to additional emergent themes (Gale *et al.*, 2013, p.3).

One method that can be used either inductively, deductively, or in combination is the 'Framework Method'. According to Gale *et al.* (2013) this involves a seven stage process, which the Getting Active disengagement research followed:

1. Transcription
2. Familiarisation with the interview
3. Coding
4. Developing a working analytical framework (or codebook)
5. Applying the analytical framework
6. Charting data into the framework matrix
7. Interpreting the data

The first two stages of this process were the same as any other thematic analysis. The audio files were transcribed (Stage 1), by a professional transcriber (this saved time and was a better allocation of resources). I then listened to the audio files whilst reading the transcripts to familiarise myself with the content (Stage 2).

Stage 3 involved a line by line labelling (or coding) of important data. There are a number of approaches to this, either inductive, deductive, or a combination of the two. I used a combined approach, basing the themes and sub-themes on the DisENGAGE Framework, following a deductive approach. This helped identify key aspects of the data that related to individuals disengaging from the DBCI. The DisENGAGE Framework themes were high-level (such as 'Navigation') so the inductive approach allowed for a more detailed set of codes, specific to the Getting Active DBCI (for example, 'Missed sections' due to 'Navigation'). The inductive approach also allowed the coding of any data that appeared to relate to disengagement. This was important because the DisENGAGE Framework is a guide but not an exhaustive list of disengagement factors.

After coding a number of transcripts the analytical framework (which will be referred to as the 'working codebook' to avoid confusion with the DisENGAGE Framework itself) began to emerge (Stage 4). It contains a set of codes and categories (grouped codes) which are potentially hierarchical in structure. It is recommended that each category has an 'other' option to code relevant data that does not currently fit into the working codebook (Gale *et al.*, 2013, p.4).

The working codebook was then applied to the remaining transcripts (Stage 5) (the term 'working' is used to illustrate the dynamic nature of the codebook). It continuously evolved until the entire data set had been coded. The codebook was agreed by a second researcher – MS.

At this stage Gale *et al.* (2013, p.5) encourages the charting of data by reducing it down into illustrative quotes (Stage 6). However, 'charting' does not always involve the reduction of data. Srivastava & Thomson (2009, p.76) explain 'charting' as arranging the original data into a chart, or table, under the relevant themes or codes. The Getting Active think-aloud data was therefore charted without reduction because the specific details of each quote were important. This analysis was carried out to explore design decisions and identify potential areas of concern for disengagement. Due to the nature of think-aloud data comments were often page specific and therefore condensing this down to generic statements would decrease their value. The think-aloud data was charted into tables, using the themes and codes, with a new row for each user. Finally, Stage 7 involved an exploration of the charted data, investigating any relationships between themes and participants. This process was also followed for the retrospective interview data.

This was a quick method to learn and helps to analyse the similarities and differences within a data set, supporting the emergence of unexpected findings (Braun & Clarke, 2006, p.97). However, this type of analysis relies heavily on the skills and abilities of the researcher, and can therefore be heavily impacted by their biases. It was therefore good to have multiple coders – such as MS – to collaborate on the development of the codebook. This also increased the validity of the analysis.

10.4 The Disengagement Analysis

The interview data was meant to provide contextual and experiential data for an individual's usage of the DBCI. However, this triangulation of data (see Section 7.1.3 for an explanation of data triangulation) highlighted an issue with the validity of the usage logs.

At the end of the interview, participants were asked how many times they had logged in to the system. This question was originally designed to reveal inconsistencies between reported and actual usage. However, during the interview with Fraser it became clear that the discrepancy between these values may have been more than inaccurate self-reporting.

Fraser self-reported that he had logged in four or five times, including twice in the first week, once the week after, and then a couple of times on the day of the interview itself (4th September). However, the usage data only logged the first session and the sessions on the interview day (see Figure 10.12).

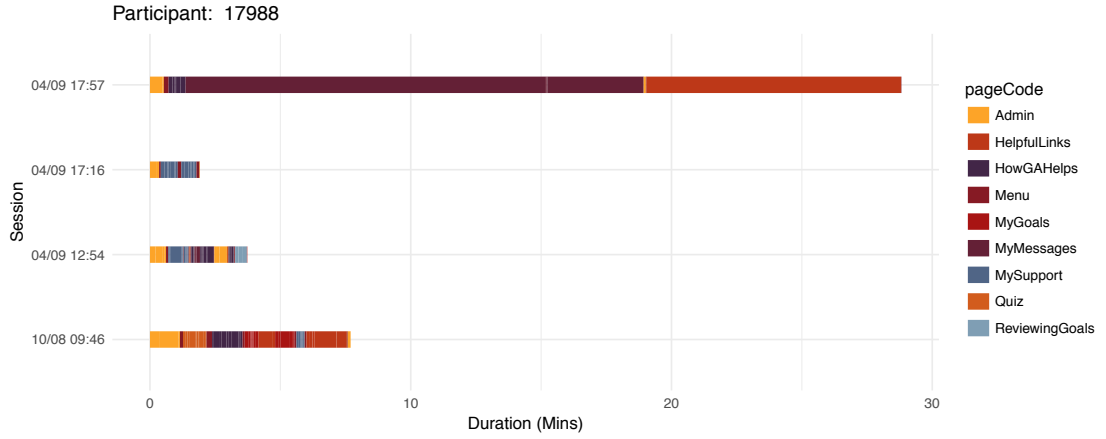

Figure 10.12: A graph showing Fraser's Getting Active sessions

Fraser appeared trustworthy and had no reason to lie, but this discrepancy could have resulted from either intentional or unintentional inaccurate self-reporting. However, this issue was not isolated to Fraser, as a few other participants appeared to have this same discrepancy and potentially missing data. This issue therefore raised concerns about the 'completeness' of the data. For this reason only the available usage data was used in this analysis.

The following section presents the findings of this disengagement research. The results and discussion are presented here under different disengagement factors in order to show how the framework can support triangulated data analysis. Each factor is explored using the stage 1 (think-aloud) and stage 2 (retrospective) analyses. This enables a holistic exploration of disengagement from the Getting Active DBCI.

10.4.1 Usability

The various stages of analysis identified a number of usability related disengagement factors (see Figure 10.13). These are explored in the following sections.

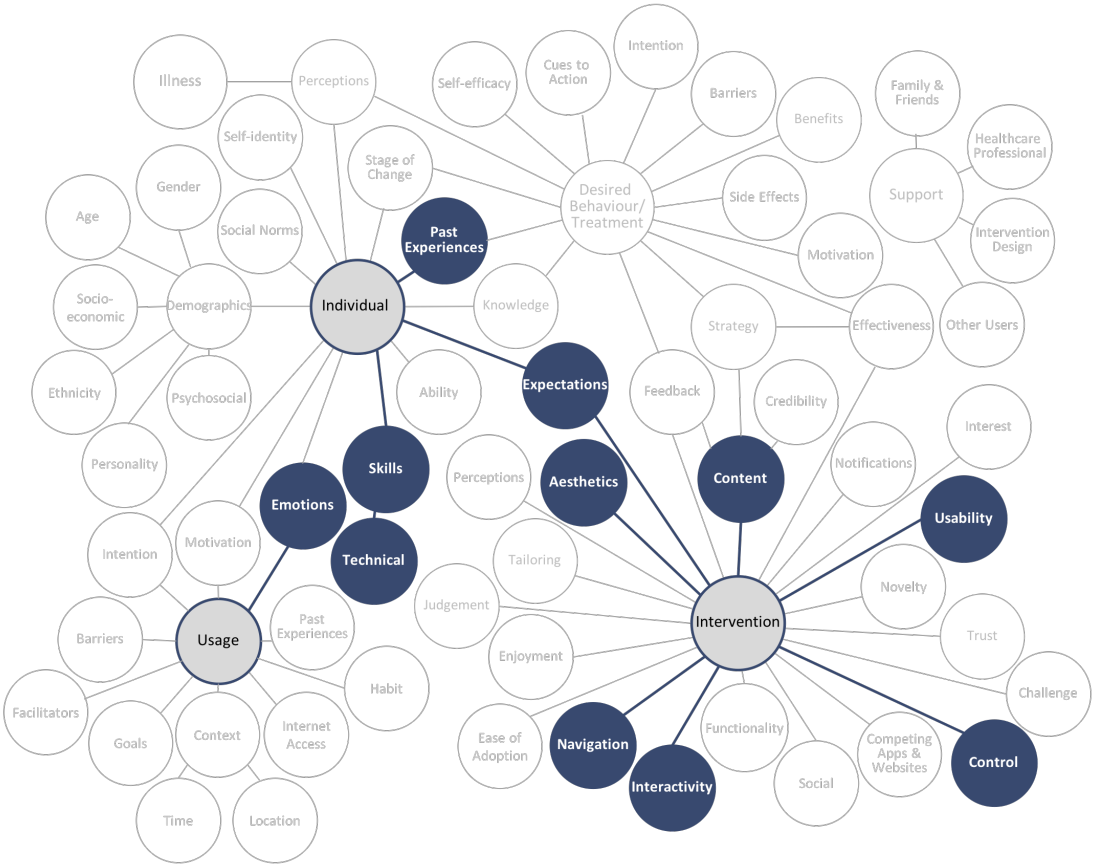

Figure 10.13: The DisENGAGE factors identified during the 'Usability' related analysis of Getting Active

10.4.1.1 Navigation

Navigation appeared to present problems for both the stage 1 (think-aloud) and stage 2 (retrospective) participants. However, these different stages and methods of data collection highlighted different aspects of the problem, including usability and the limiting of the user's sense of control.

Several stage 1 (think-aloud) participants appeared to have issues trying to navigate the intervention. They were often unsure about their location in the system, where a link would take them, or whether they had already visited a particular section before. This uncertainty understandably influenced how the participants chose to interact with the DBCI. For example, Cara decided not to click on a link for additional information in case she lost her place in the quiz. In fact, that particular information page was only

accessible through this link and there was a 'back' button which returned the user to that point in the quiz.

> '[*Quiz – Question 2*] I'm tempted to click here now, but I'm worried that it will bring me out of the quiz, so I'll just keep going' - *Cara*, 33 (Stage 1)

These issues were only discovered because the think-aloud method enabled participants to verbalise their thought process whilst using the intervention. This also highlighted an interesting inconsistency between real-time data (collected during the think-aloud) and summary data (collected at the end of the think-aloud). A number of the participants who struggled navigating the system gave a positive response when asked about navigation at the end of the session. For example, Zoe asked whether she had 'done them all now?' – referring to the different sections of the site – when she had only explored half of the site. Yet she claimed that it was easy to navigate.

> 'It's not difficult to find your way round, or anything, so yes, it's quite nice to use' - *Zoe*, 24 (Stage 1)

Navigation appeared to present a number of issues for the stage 1 participants. However, it is possible that these interactions were given undue prominence by the nature of the data collection. There is a learning curve associated with using a new technical system, referred to as 'learnability' (Tullis & Albert, 2013, p.92). This data, which seems to suggest usability issues, may in fact be highlighting a learning curve, which - once mastered - may not impact the user's experience.

The planning for data collection in stage 2 used the DisENGAGE Framework to identify the aspects of the design that might lead to disengagement. For this reason, navigation was specifically explored in stage 2 and participants were asked to 'Talk me through what it was like navigating around the website'. This ensured that navigational data was collected and analysed.

The inconsistencies in feedback from the participants continued in stage 2 (retrospective). The majority of participants stated that the navigation was simple or easy to use, though some stated that it was unintuitive or required too many clicks to progress through the pages. Amelia, for example, was positive about the overall system structure but nonetheless struggled with navigation.

> 'I kind of liked the structure apart from the fact that I couldn't sort of move about as I wanted to' - *Amelia*, 33 (Stage 2)

In addition to these usability concerns, a number of participants found that they could not use the DBCI as they wanted. Grace and Mia tend to scan a site quickly in order

to locate the content that interests them. If a site does not facilitate this type of usage, both users describe feelings of negativity which often lead them to disengage. They were both critical about this aspect of the intervention and did not like their perceived lack of control.

> 'Once I got in [the website], there was probably more in there that I could do, but I didn't know that from the outside. So that's just, that is to do with me. I need short, sharp ... if I can't do it in 30 seconds [...] I move away from it' - *Mia*, 57 (Stage 2)

These two sets of data (from stages 1 and 2) provide interesting insights about DBCI usage. Several participants from both stages found the DBCI difficult to navigate and were unsure about their location in the system or whether they had been to a particular section before. As a result, the current navigational structure did not support a number of the participants in their normal patterns of website usage, thereby reducing their levels of control.

There are a number of ways in which the intervention design can alleviate these navigational issues, including navigational breadcrumbs, site maps, and search bars (Krug, 2006). Navigational breadcrumbs can inform the user about their location in the system, whilst a better understanding of the architecture – for example by providing a sitemap – can help the user to know which sections they have visited before. Finally, a search bar can increase a user's sense of control, allowing them to quickly explore and locate the content they want.

The contradictory comments from various participants may have been due to their understanding of the interview questions. A few participants referred to the easy 'next' and 'back' buttons but appeared to be confused by the overall architecture. These participants may have understood navigation to mean passing from page to page. However, good navigation does not just support page to page navigation; it also informs the user where they are in the system, which section or subsection they are in, and how to search or find what they require (Krug, 2006, p.61). Navigational issues are a serious concern because if a user can't navigate a site easily, they will quickly stop using it (Krug, 2006, p.51). Implementing the recommendations below, should help to reduce some of these navigational problems.

- Create a sitemap (Navigation).
- Use breadcrumb navigation to show which section the user is in (Navigation).
- Create a global and local navigation bar with sections and subsections (Navigation).

10.4.1.2 Aesthetics

During the think-aloud (stage 1) participants were prompted when they arrived on the first page to answer the following question: 'What are your first impressions of this page?'. The aim was to capture their initial reactions to the aesthetics and related factors.

In connection with this, many of the participants appeared unsure about what to do next or how the intervention would respond. These issues were often caused by the use of particular colours or choices of fonts, which lead users to expect certain types of functionality (see Figure 10.14).

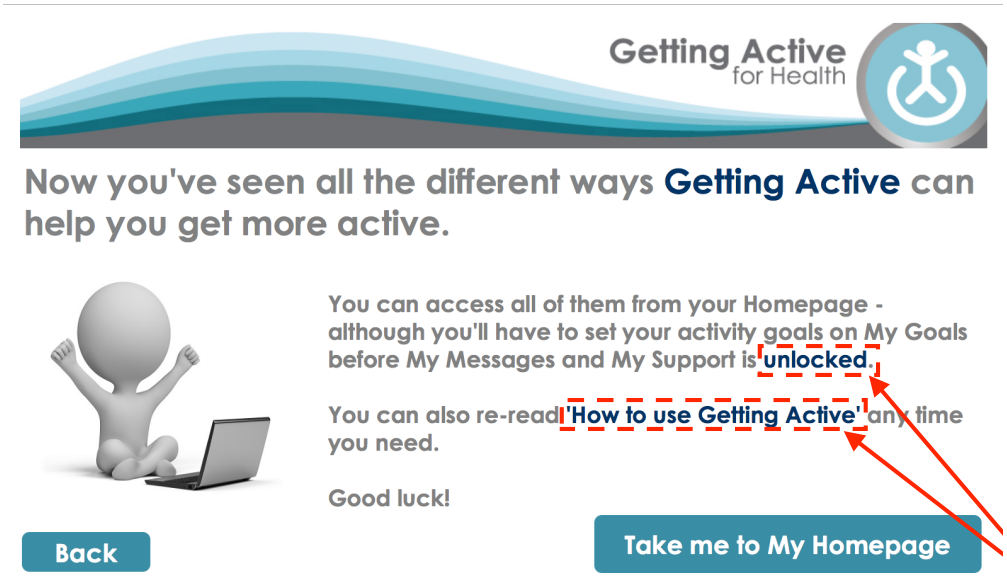

Figure 10.14: An example of misleading aesthetics in Getting Active

For example, several stage 1 participants mistakenly thought that the different use of colour indicated a hyperlink. This problem was also highlighted by the stage 2 (retrospective) participants. Amelia explained that it was standard practice on websites to use colour to represent links, highlighting her previous experience with technology and her technical skills. This led her to expect a certain type of navigational functionality. As a result of this, the mismatch between past experience and current expectation led to a strong negative emotional reaction.

> '[using the Internet regularly] you learn that different colour text means there's a link, but there isn't. So, I tried clicking everywhere and there was just nothing, and that really pissed me off' - *Amelia*, 33 (Stage 2)

This analysis highlighted the importance of the relationship between various factors of the framework (see Figure 10.15). Aesthetics can relate to images and colours but in this case also had an impact on the usability and navigation of the system. The colour, font, and size of text can therefore be critical in navigational design (Kalbach, 2007, p.19). Users have learnt from their past experience that these visual cues communicate certain forms of interactivity and therefore failing to follow these common practices leaves them confused and frustrated.

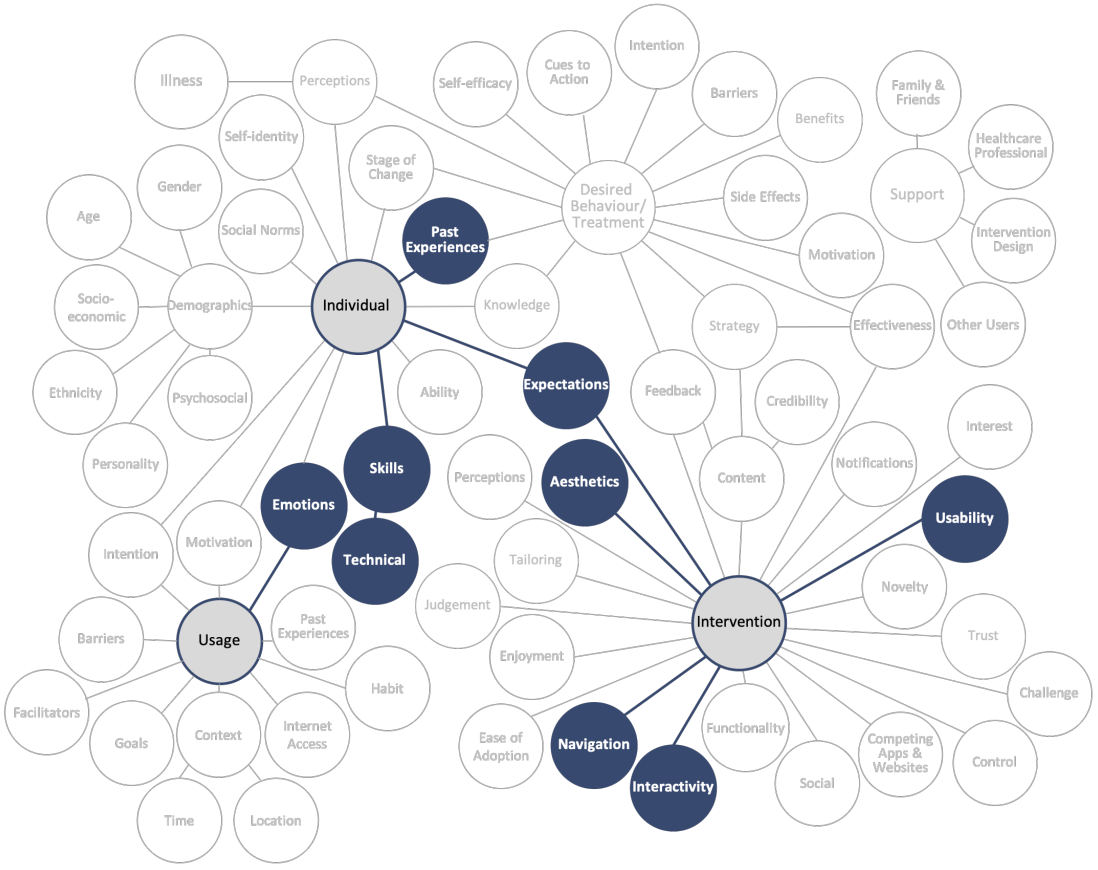

Figure 10.15: The DisENGAGE factors identified during the 'Aesthetics' related analysis of the Getting Active

Designers could remove the additional colour and see if users still identified this bold text as a link. Alternatively, the designer might consider making these words into links as many of the participants clearly wanted to click on them, either to see more information or to go to that section of the site. Further investigation during a think-aloud could help to identify, which of the following recommendations is the appropriate solution.

- Remove the differentiating colour from the font (Aesthetics).
- Make the emphasised text into links (Navigation).

10.4.1.3 Content

The labelling of sections can either help or prevent a participant from successfully navigating a site, and in Getting Active seemed to lead to a number of users overlooking or missing parts of the programme content. Lena's usage (stage 2), for example, showed that she had only clicked on the 'My Support' section once, and only stayed on it for a matter of seconds (see Figure 10.16).

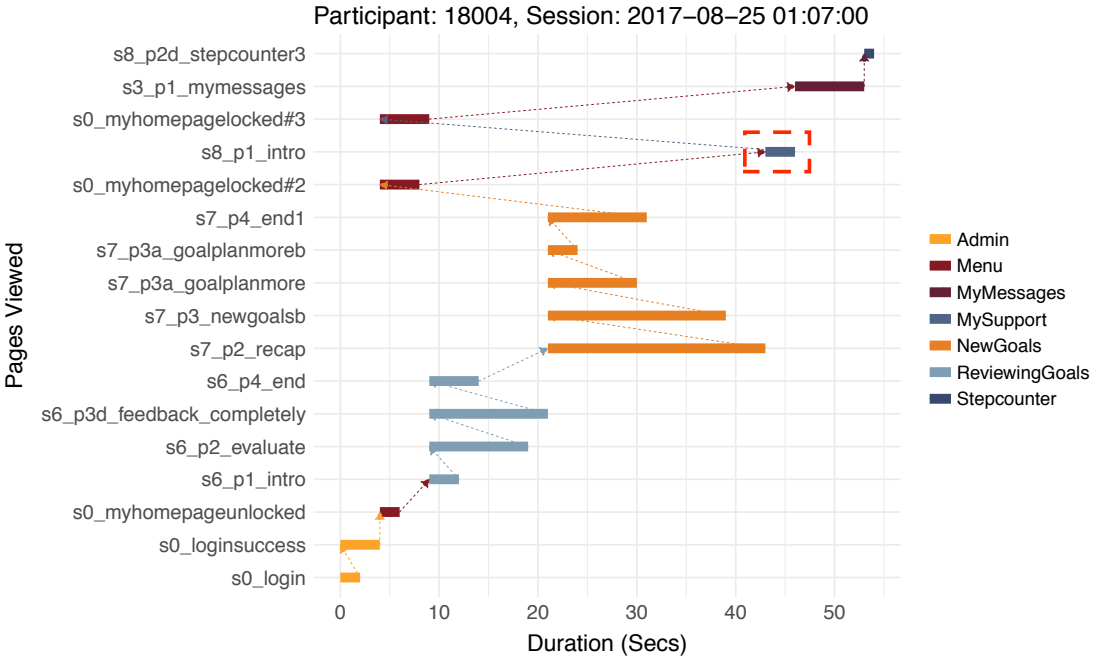

Figure 10.16: A page flow graph showing Lena's only visit to the 'My Support' section of Getting Active

This usage sequence could imply that Lena was not interested in the safety-related content presented in that section, leading her to digitally disengage from that part of the intervention. She explained in the follow-up interview that she had not looked at that section because she did not think it was relevant to her. However, later in the interview she explicitly stated that she had expected some content about safety and being active with asthma, content that would have been found in the 'My Support' section of the site. This unclear labelling led to Lena's digital disengagement and could result in similar outcomes for other participants.

> 'I'd already done the quiz and I feel like I manage my asthma fairly well so I guess I don't really feel like I needed support' - *Lena*, 27 (Stage 2)

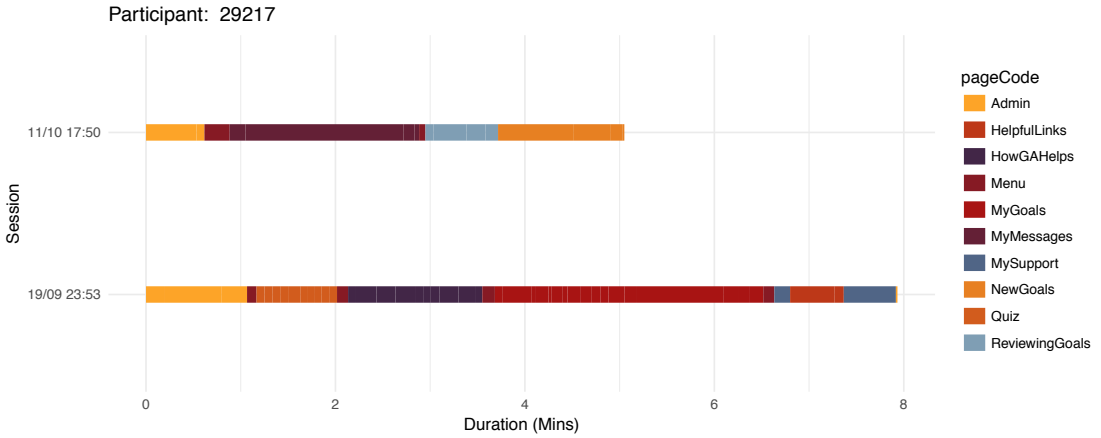

Figure 10.17: A graph to show Mia's Getting Active sessions

Mia's usage (stage 2) also suggested that she had not explored this section (see Figure 10.17), a fact that was confirmed in the interview. Mia explained that she either 'didn't know how to get there' or 'probably didn't look'. However, when the contents of that section was explained to her she said she would have been interested in that information. Several other participants explained that they had avoided the section because they were unsure about its content. They felt that they had enough support, or thought that the title implied technical support, which they did not require.

> 'I would have expected almost support about how to use [the website] almost, like mainly how to use the website under support' - *Christoph*, 26 (Stage 2)

The labelling of this section seems to have acted as a barrier for a number of participants. Their assumptions regarding its content led them to avoid it, rather than explore its content. This simple issue of naming a section poorly has resulted in participants digitally disengaging from it, even though it contained content that they would have been interested in. Furthermore, the time spent by the intervention designer to create these pages was wasted.

The Getting Active designers may have tried to use clever consistent labelling that followed a specific theme, starting with 'My': 'My Messages', 'My Goals', and 'My Support', rather than using labels that were more descriptive (and therefore more obviously helpful). These *clever* labels may sound good but are actually counterproductive as they do not help the user to navigate the system (Kalbach, 2007, p.124). Research has shown that the chances of two people using the same descriptive word for a section is low and therefore labels should be as self-explanatory as possible (Kalbach, 2007, p.141). Renaming the 'My Support' section or providing a short description of its contents may remove this disengagement factor. A think-aloud study can help with this process, asking participants to explain what they expect to be in each section according to its label.

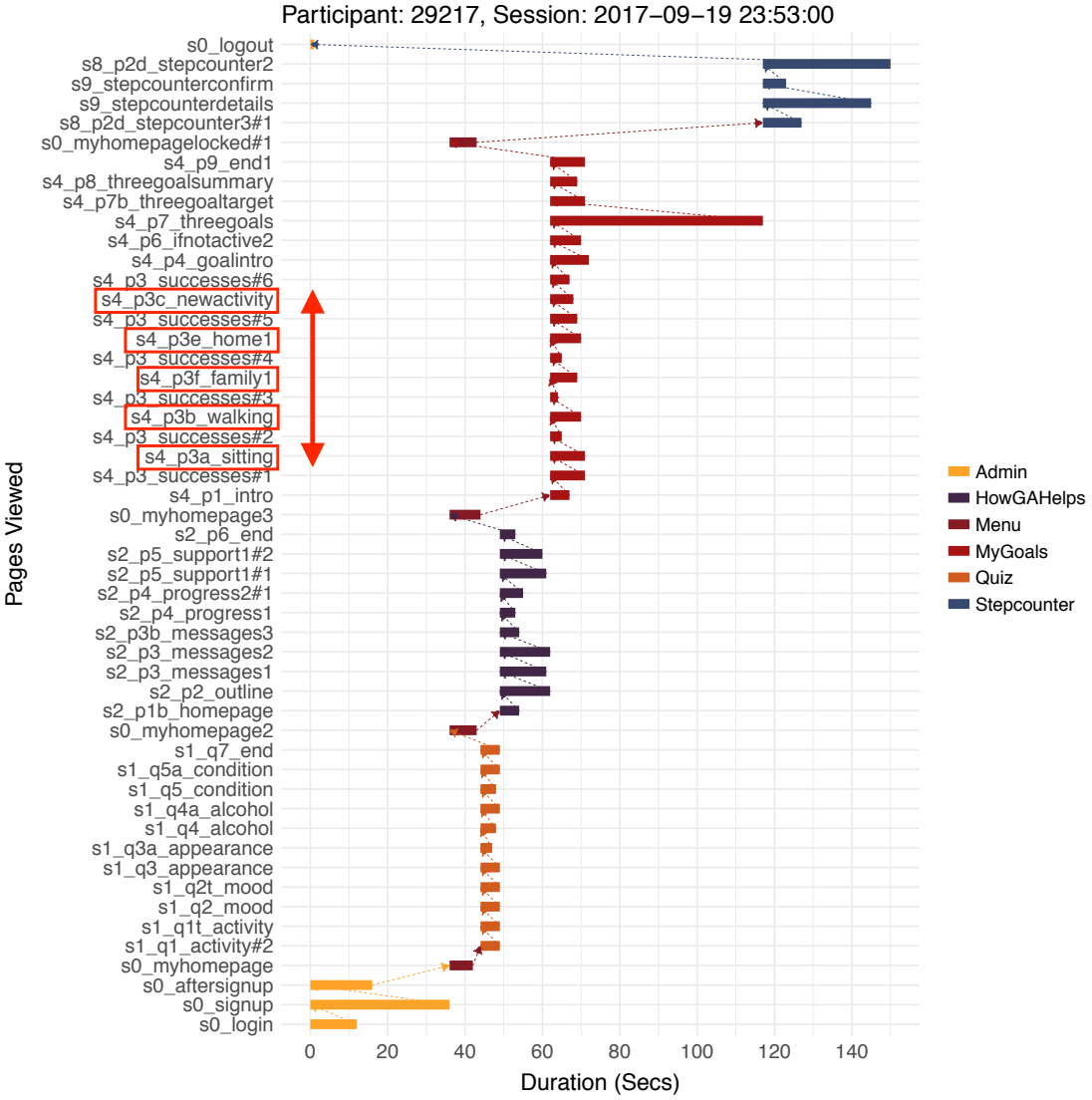

Figure 10.18: Mia's missed opportunities to see the 'Success Stories' in Getting Active

Participants – including Lena and Mia (both stage 2) – also commented that they had not seen any of the success stories. Figure 10.18 presents one of Mia's sessions. The highlighted page names on the left of the graph show the pages that had links or tabs containing a success story. The fact that certain page names are not present on the graph shows that Mia did not click on any of these links or tabs (see Figures 10.19 and 10.20 for example pages with links and tabs).

Success stories were also located in links at the bottom of a page. The fact that a number of individuals did not see these stories and Mia's pattern of usage suggests that a significant number of users did not pick up on these links and therefore did not see the stories. It is possible that this missed content is due to a phenomenon called 'satisficing' – a user choosing the first reasonable option rather than choosing the best option (Krug, 2006, p.24). When this is applied to navigation, users might be distracted by the larger

more eye-catching buttons rather than the tabs or smaller link text. This reiterates a concern about the navigation (structure of the site) but also indicates that page layout may be a factor contributing to missed content.

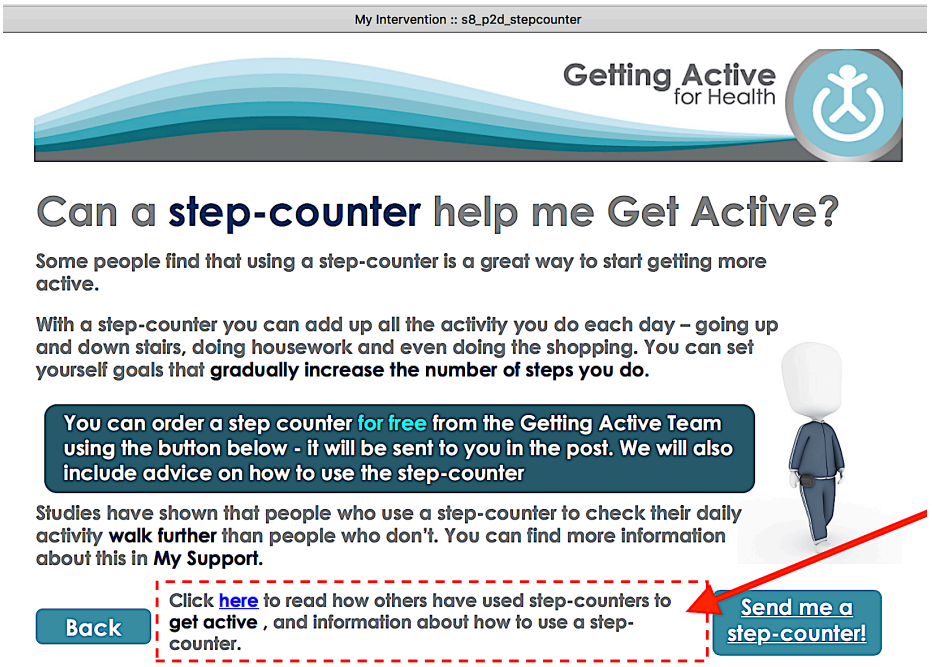

Figure 10.19: An example of a Getting Active 'Success Story' link

Figure 10.20: An example of a Getting Active 'Success Story' tab

Success stories are a form of 'social modelling', which is a well-established behaviour change technique (Yardley *et al.*, 2015, p.12). These stories included accounts of how others overcame barriers to their behaviour change attempts. They are also designed to

promote feelings of competence (Yardley *et al.*, 2015, p.12). It is therefore concerning that a number of participants were unaware of this content. The navigational tools discussed previously should help to prevent this kind of missed content but there are some additional recommendations that could be considered.

- Use colour or font size to draw attention to a link when a cursor hovers over it (Aesthetics, Interactivity).
- Change the type of cursor when it hovers over a link (Aesthetics, Interactivity).
- Rename sections of the site using more descriptive language, and include short explanations of content (Navigation, Content).
- Change the layout of the page (Layout).
- Put success stories in their own section (Navigation, Layout).

10.4.1.4 Summary and Recommendations

This section has identified a number of usability related disengagement factors but in addition identified layout as a potential factor to cause digital disengagement (see Figure 10.21).

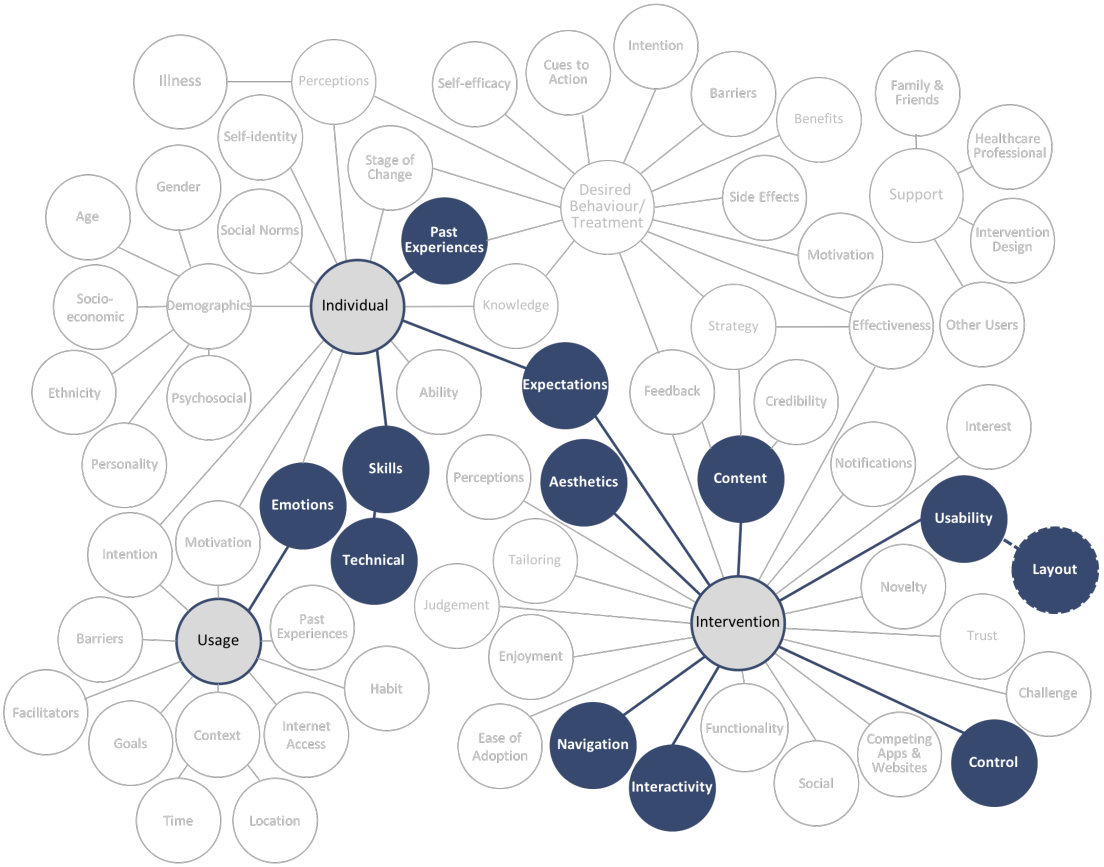

Figure 10.21: The updated DisENGAGE factors which emerged during the 'Usability' related analysis of the Getting Active

Navigation seems to have caused a number of issues for participants and users can quickly tire of a system that they find difficult to use. There are in fact a number of common practices used in website design to indicate links clearly. Yet users in this study were finding that their assumptions (based on their past experience and technical skills) were often incorrect in respect to the Getting Active design. This led to a variety of negative emotions, including frustration and confusion. A number of participants were also misled by the labelling of the website sections. This prevented several participants from locating content that they would have been interested in.

Finally the page layout may have prevented a number of participants from finding the success stories. These stories are part of the behaviour change strategy and aim to provide guidance and motivation for the individuals. This missed content was a wasted opportunity.

Usability issues lead to digital disengagement and these issues should be addressed using the following recommendations from this section.

- Create a sitemap (Navigation).
- Use breadcrumb navigation to show which section the user is in (Navigation).
- Create a global and local navigation bar with sections and subsections (Navigation).
- Remove the differentiating colour from the font (Aesthetics).
- Make the emphasised text into links (Navigation).
- Use colour or font size to draw attention to a link when a cursor hovers over it (Aesthetics, Interactivity).
- Change the type of cursor when it hovers over a link (Aesthetics, Interactivity).
- Rename sections of the site using more descriptive language, and include short explanations of content (Navigation, Content).
- Change the layout of the page (Layout).
- Put success stories in their own section (Navigation, Layout).

10.4.2 Notifications

The majority of the stage 1 (think-aloud) participants felt that they received too many emails on a daily basis and as a result they tended to ignore them. Many participants liked the fact that they could control the frequency of Getting Active emails. However, John was unclear regarding the purpose of these messages just at the point where he had to select their frequency. This might well have affected his choice about how often to receive them.

> 'At this stage, I'm not clear exactly what the content would be of these emails' - *John*, 39 (Stage 1)

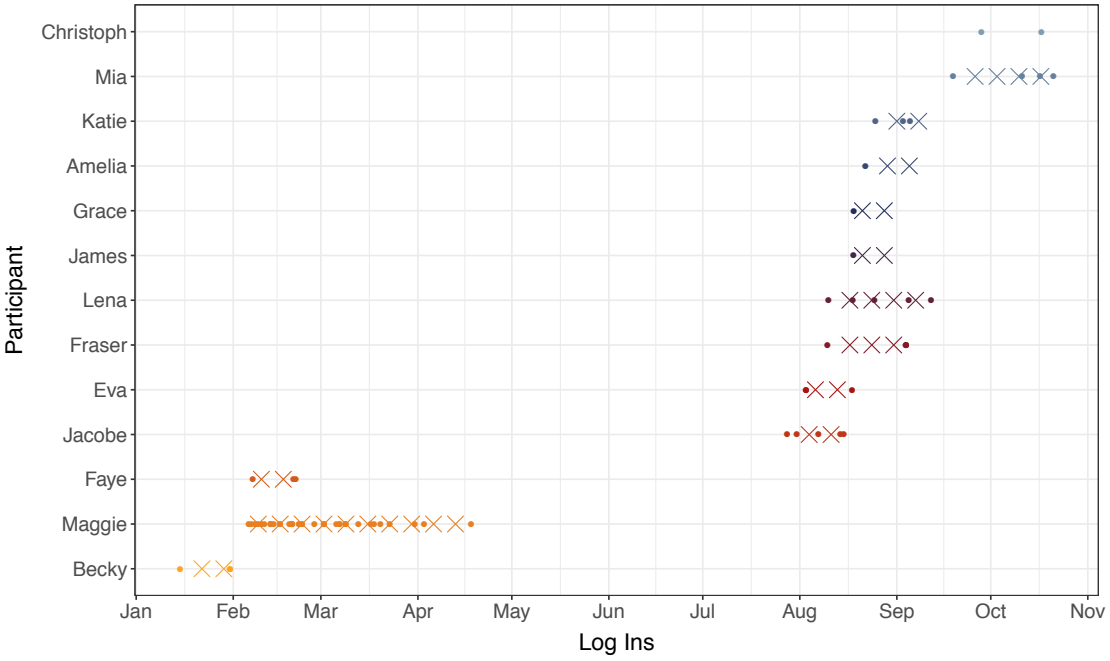

Figure 10.22: A graph showing the login and notification points (X) for each Getting Active participant

On the other hand, the stage 2 (retrospective) participants were very positive about the emails they received. Figure 10.22 shows a number of participants (including Lena and Katie) who appeared to log in after an email from Getting Active. This was confirmed during the interviews as many participants explained that the emails acted as a reminder to update their goals. For other users, the emails acted as a prompt or nudge to achieve their goals or do some activity. However, Amelia was confused by the emails, unclear at first as to who they were from.

> 'The email address had nothing to do with it, the title had nothing to do with it, the subject line, everything was unknown. I first thought it was spam' - *Amelia*, 33 (Stage 2)

Several stage 2 participants stated that emails were not the best form of notification for them. For example, although Christoph thought they were a good idea, he decided not to use this feature due to the number of emails he already receives. Several participants discussed other forms of notification that they would have preferred, including social media and pop-up phone notifications.

> '[M]aybe you could connect it to alerting devices like phones, so you could create a reminder that wouldn't let you forget to do it, which would be nice' - *Faye*, 22 (Stage 2)

Jacobe explained that he would have liked to receive more emails to remind him to do an activity and yet he did not tailor the frequency of notifications in the DBCI. Potentially he might have set a higher frequency of messages at the point of setup if he had known what that would entail.

> 'Yeah, when you're setting it up, initially, I don't think anyone wants to sign up to something that will give them really regular emails. But at the same time some unexpected ones may then actually help to keep them engaged' - *Jacobe*, 29 (Stage 2)

Emails had both a behavioural and digital impact. They acted as a nudge (behavioural), either reminding the user that they had set goals, or directly prompting an activity. However, the emails also prompted individuals to log back into the system (digital); a casual relationship that is currently not easily tracked in LifeGuide.

By exploring the role of notifications within this behaviour change process, intervention designers can consider additional ways to support their users. A number of participants were unclear at the point of setup about these notifications. Users were wary of setting a high frequency of messages and were unsure what these notifications would contain. There was a link at the bottom of the page that led to a page that explained how others had successfully utilised the notifications (a type of success story). However, it is likely that these individuals did not see this content. It might be beneficial to move this information – about the positive behavioural and digital impact – to the email setup page as this might encourage individuals to increase the frequency of their notifications.

Furthermore, these notifications could be tailored to more effectively support their activity attempts. Asking an individual to commit to a date and time of activity would enable time-conscious notifications, which could nudge and encourage the user. A number of participants also wanted other forms of notifications – such as a phone pop-ups – which could easily be implemented in the DBCI.

It is important not to bombard users with emails; they should have control over the frequency and they should be relevant to them (Dennison *et al.*, 2013). It is a feature that they would have to opt-in for, ensuring they were happy with the level of prompting. However, there are a number of ways in which this feature could deliver a better service for the users.

10.4.2.1 Summary and Recommendations

The Getting Active emails had a behavioural and digital impact on the users. They acted as nudges to either carry out the desired behaviour (cues to action) or to log in to the system (facilitators of usage). The emails were seen as an extension of the

DBCI, but several participants were unclear about what to expect from their contents. The participants were happy with the ability to tailor the frequency of emails. Figure 10.23 shows the various ways in which the Getting Active notifications can offer support, including the positive impacts – which can potentially be monopolised – and the potential areas of improvement.

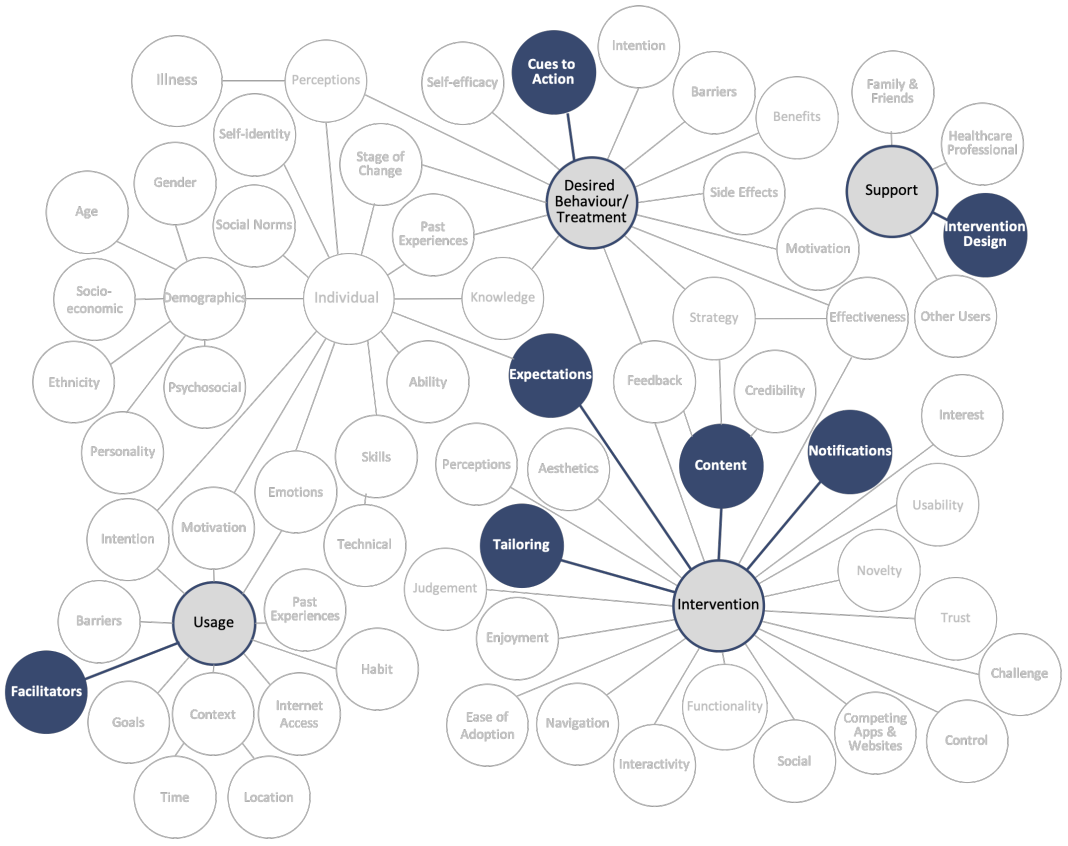

Figure 10.23: The DisENGAGE factors identified during the 'Notifications' related analysis of the Getting Active

The following recommendations help to increase the positive impact that notifications can potentially have and improve the DBCI's ability to support users.

- Make the emails more easily identifiable using a more descriptive subject line (Notifications, Content).
- Provide more information during set-up to explain the role of the notifications and the positive impact they can have digitally and behaviourally (Notifications, Content).
- Add feature for time-conscious activity prompting (Notifications, Cues to Action, Intervention Design (Support)).
- Explore and implement other forms of notifications (Notifications, Facilitators (Usage)).

10.4.3 (Future) Usage Intention

One of the most important aspects of the Getting Active study was whether the participants would use the DBCI in the future. Most stage 1 participants said that they would 'probably' give the intervention a go but were unwilling to commit to this, despite their positive comments about the DBCI.

> '[If GP asked you to use it?] I'd probably have a look at it' - *Beth*, 29 (Stage 1)

However, these participants were basing this decision on a short initial exploration of the DBCI without having had the opportunity to try it in a real-world setting. To provide further understanding about the likelihood of adoption, the stage 2 participants were specifically asked about their future use.

The majority of stage 2 participants initially indicated that they would use the intervention in the future, either to explore sections they had not looked at or to continue with the goal setting functionality. However, when this was followed up by a second question – asking whether they would *actually* use it – the majority of participants said it was unlikely.

> 'That's hard to say. You should probably come back to me and ask me in a couple of months. Yeah, maybe [...] Only maybe. Probably, 30% maybe' - *Mia*, 57 (Stage 2)

The following sections explore the possible reasons for potential disengagement in the future, i.e., predicting factors of disengagement. These include the lack of behavioural intention, the functionality of the DBCI, the lack of feedback, an individual's strategy to their behaviour change attempt, competing apps and websites (and expectations), and ease of adoption (see Figure 10.24).

10.4.3.1 Strategy

Analysing usage data alone, Grace would have been considered a non-user or disengaged participant because she only had one logged session in the database (see Figure 10.25). However, she may have logged in a second time to ensure that she could answer the interview questions.

> 'Actually, you could well have rung me and I'd not been on the website. That could also have been a factor' - *Grace*, 59 (Stage 2)

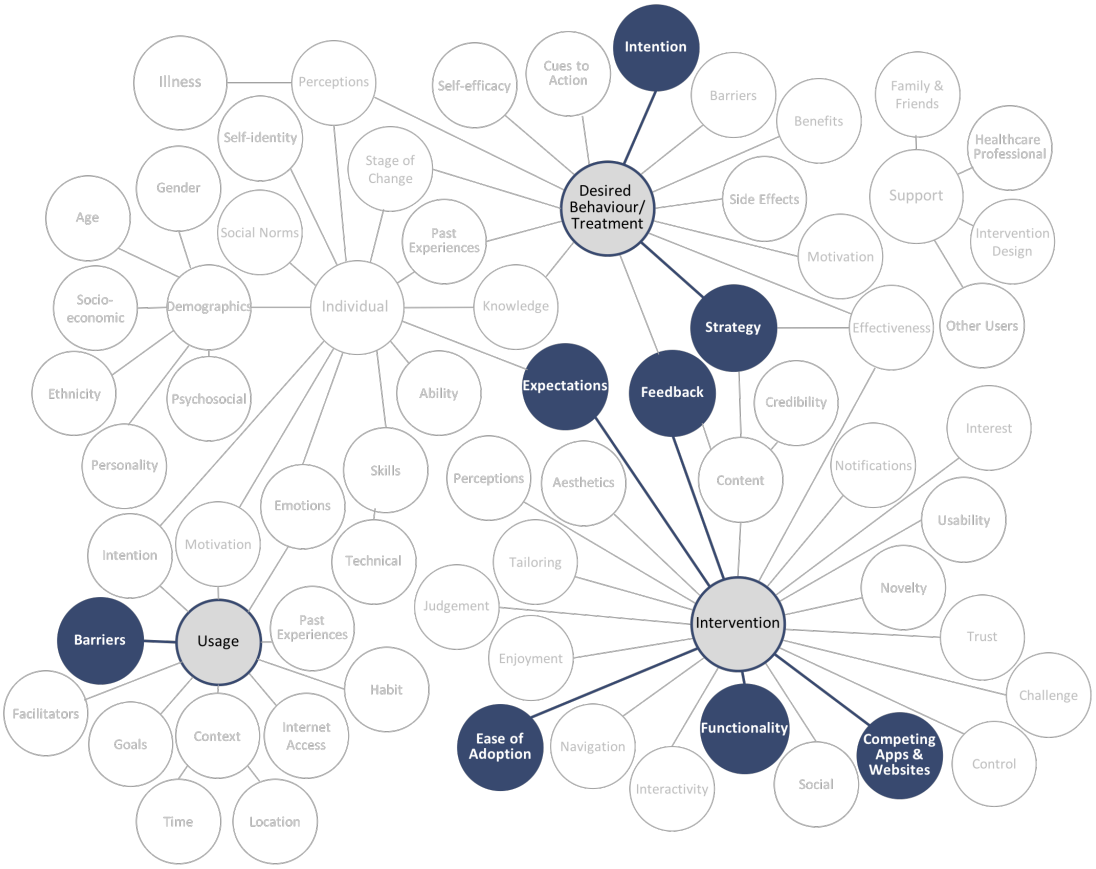

Figure 10.24: The DisENGAGE factors identified which might lead to disengagement (in the future) from Getting Active

This usage data would imply that the DBCI had not worked for her and that she had digitally (and potentially behaviourally) disengaged. However, Grace actually printed the activity plan, pinned it to her wall and ticked it off each time she completed a goal. This underlines the risk of ignoring offline activity and the incorrect assumptions that can be drawn. This is particularly problematic when analysis is based solely on digital traces in usage logs.

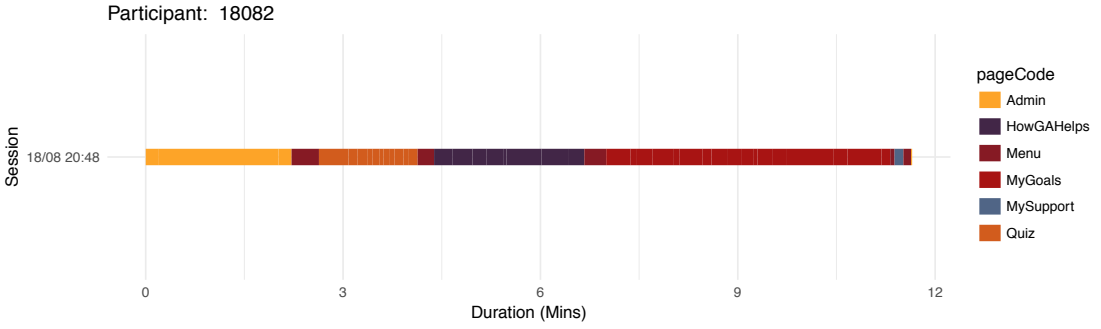

Figure 10.25: An overview graph of Grace's Sessions

This user actually had a high level of engagement with the behaviour change process. In previous research she would have been categorised as a dropout and the full impact of the intervention would not have been understood. Providing a print out activity plan facilitated this individual's behaviour change attempt. However, it may also have led to her digitally disengaging as she did not need to log in to review her goals. In this case the overall aim – to help users increase their activity – was successful, but she is unlikely to use the DBCI in the future.

10.4.3.2 Behavioural Intention

Stage 1 participants provided a list of barriers that prevent them from being more active. A number of participants wanted someone to be active with – to support and encourage them – especially as a few had bad experiences when previously trying to increase their activity levels.

> 'Last time I went swimming, I only managed to do a few lengths in the pool, and have an asthma attack, and I was on my own [...] I'd love to go swimming again, but I know that I need to not go on my own' - *Beth*, 29 (Stage 1)

However, a number of participants – such as John and Melissa (both stage 1) – stated that their inactivity was due to laziness or finding it difficult to get back into a routine of activity. Some stage 2 participants also reported similar obstacles to their activity goals, which included leaving work late, procrastination, or simply '*life*'.

> '[Why didn't you achieve your second week goals?] So, like life got in the way sort of ... sort of excuse. And it's not a good excuse' - *James*, 33 (Stage 2)

Several participants discussed setting goals that they knew they would easily achieve and had already planned to complete. Mia explained that she wanted more guidance because she did not know how to get fitter – after all, she was 'not the expert' – and this might have resulted in her setting *easy* goals. This highlights both Mia's digital engagement but behavioural disengagement. However, she realised that these goals actually had some negative consequences.

> 'In a way, [setting easy goals] let me off the hook, because all I had to do was make sure in the first three weeks that I went up and down the stairs 10 or 20 times [...] it made me think I was doing a bit better than I actually was' - *Mia*, 57 (Stage 2)

Setting easy goals may indicate that these particular users were using the DBCI to 'take part' in the study rather than to change their behaviour. It also might illustrate that they were not ready to commit to this behaviour change process potentially being in the *wrong* 'stage of change' (part of the 'Transtheoretical Model' (TTM), which explains that a participant needs to be in the 'action' stage before they will carry out a particular behaviour (Prochaska & Velicer, 1997, p.39)). Despite this apparent lack of commitment, Mia discussed her desire to be more intentional about activity, and to schedule it into her diary and log these attempts. She wanted something that 'encouraged' or 'informed' her. This was the purpose of Getting Active but it is clearly not meeting Mia's requirements. Regrettably, this will lead to her disengaging from the DBCI. Furthermore, without further support or guidance, Mia will struggle to change her behaviour, which in turn may lead to behavioural disengagement.

Amelia was another who discussed wanting to continue her attempt to be more active. However, she specifically stated that she would not use the DBCI for this and therefore would digitally disengage in the future.

> 'If I'm honest I don't think I will [use it in the future]. But I might use this as learning experience to actually go and ... go back to the gym [...] maybe I should start setting these goals again. I just have to find a way of actually measuring them' - *Amelia*, 33

10.4.3.2.1 Summary

Participants raised a number of factors that affected their behavioural intent, including the addition of the 'target audience' factor (see Figure 10.26). For some of these individuals – like James – changing their behaviour did not seem to be a high enough priority, and therefore potentially these individuals were not the target audience. This may have been due to their stage of change, motivation, or self-efficacy. However, a number of participants also discussed a need for support from family and friends or mentioned other barriers to activity.

Setting easy goals may have highlighted that some individuals' usage goals were to test the DBCI rather than increase their activity. However, both Mia and Amelia discussed a desire to be more active (behavioural intention) but had no intention of using the DBCI to achieve this goal (digital disengagement). There are a number of potential reasons for this, including lack of guidance, which will be explored in more detail below.

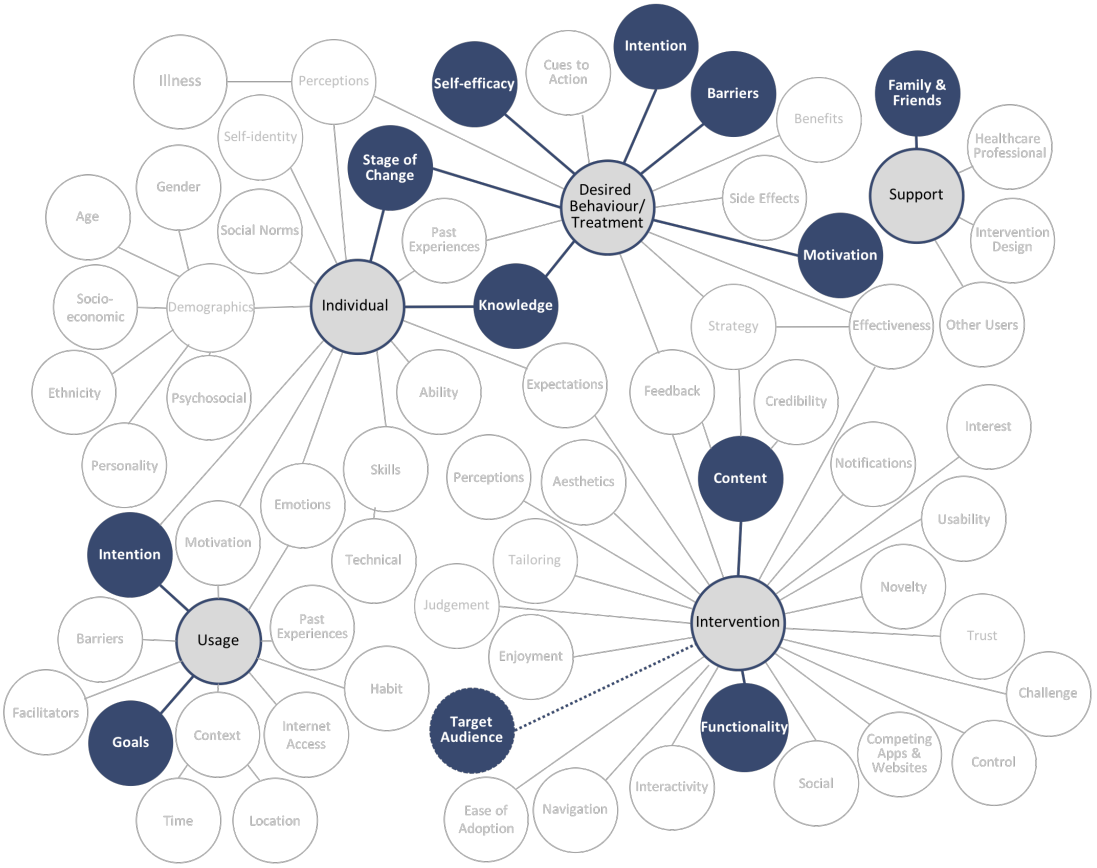

Figure 10.26: The DisENGAGE factors identified during the 'Behavioural Intention' related analysis of the Getting Active

10.4.3.3 Functionality

Stage 2 participants identified that the aim of the intervention was to support asthma-sufferers by providing motivational and informative content and offering a goal setting feature. However, the majority of these participants stated that they did not learn much from the DBCI. This meant that the users were unlikely to return for the content but may have returned to use the goal setting functionality.

> 'I don't think there was much I didn't know' - *Lena*, 27 (Stage 2)

Beth (stage 1) particularly asked for more guidance during the goal setting process. Her understanding of the level of guidance she was about to receive changed on a page-by-page basis. At one point she stated that if she were at home – not in a think-aloud study – she would have digitally disengaged due to this uncertainty. Several stage 2 participants also requested more guidance.

> 'I think I want a bit more guidance, as well. I don't want someone saying to me, what would you like to do? Actually, I don't know what I need to do in order to get a bit fitter. I'm not that much of an expert' - *Mia*, 57 (Stage 2)

Participants raised a number of concerns about the goal setting functionality, which included the lack of guidance during the goal setting process and the lack of control over the goals that they could set. They found the format inflexible and wanted the ability to set more specific goals – such as time-dependent activity – and they also wanted additional goal options.

> 'The goal setting a little bit coarse in terms of like what I could get it to do [...] that wasn't quite as flexible as I had hoped, and I had to like ... I felt a little bit like I was having to force what I wanted to do into the ... into like the format it was asking to' - *James*, 33 (Stage 2)

These issues – lack of guidance and the lack of control over the goals – presented a significant problem for many of the participants. Furthermore, setting specific rather than general goals leads to more successful behaviour change attempts (Michie *et al.*, 2014a, p.150); it is therefore likely that increasing the granularity of the goal setting feature will improve the effectiveness of this behaviour change strategy.

Currently, this intervention appears not to fulfil its requirements and therefore may not be considered useful. This relates to Venkatesh & Bala's (2008) concept of 'perceived usefulness' from TAM3 (see Section 5.1.1.4). 'Perceived usefulness' is the calculation made by the user of the system's ability to help or achieve a specific job goal; in this case support their self-management of asthma and their intention to increase their activity levels.

To increase the utility of Getting Active a number of stage 2 participants requested additional features – such as tracking additional health-related information (including asthma-specific data), interoperability with other apps (ease of adoption), and linking with other users of the DBCI (social).

> 'In like a chart, you know you can actually track your information and it will store it for you; that would be really good' - *Becky*, 36 (Stage 2)

An additional feature was highlighted through the think-aloud data. Many of the individuals often forgot to carry their inhalers with them. A reminder system could reduce this burden on users and reduce the likelihood of a bad asthma attack. Collecting data about the individual's experience of their illness and their attempts to be more active provided additional ways in which the DBCI could support their ongoing self-management.

> 'Remembering to carry the Ventolin is easy. Remembering to take the steroid one, even after 38 years of having asthma, it's still difficult to remember to do it, and to include it as part of a bedtime routine' - *John*, 30 (Stage 1)

Without these extra features, the utility of Getting Active is drawn into question as the main goal setting functionality did not meet requirements.

10.4.3.3.1 Summary and Recommendations

The DBCI did not appear to meet the requirements of the individuals, which related to a number of disengagement factors, including the addition of the 'utility' factor (see Figure 10.27). Participants wanted more guidance (in the content) and support (within the intervention design) because they lacked the knowledge to know how to set their own goals. Many participants wanted more control over the goals that they could set, which would increase the effectiveness of this strategy. To increase the utility of the DBCI, participants also wanted interoperability with other apps (ease of adoption) and the ability to link with other users (social).

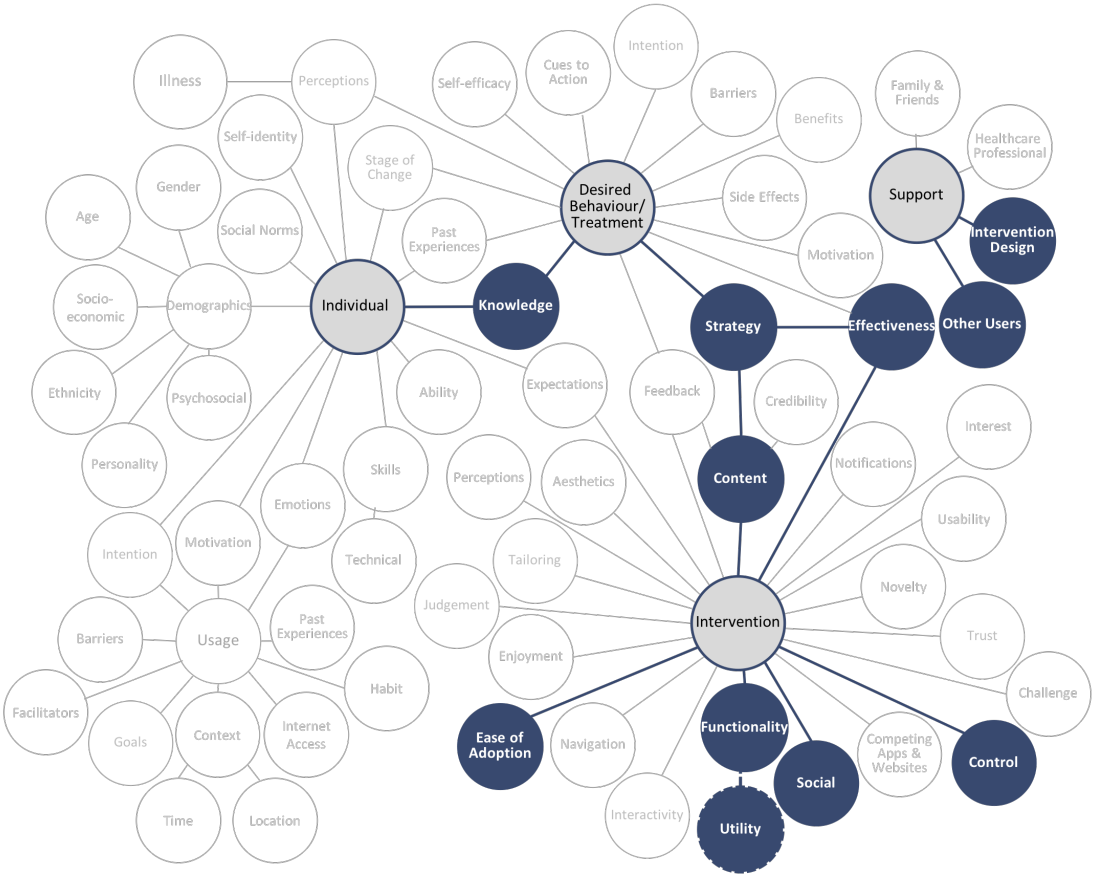

Figure 10.27: The DisENGAGE factors relating to the Getting Active 'Functionality'

The following recommendations may help to address these issues. However, it is important to consider the format of guidance because goals that are pre-defined or too specific can cause additional problems, particularly if it affects the individual's sense of autonomy (Latham & Locke, 1991, p.214).

- Provide some explanation during the goal setting process; for example in the form of established best practices, such as the role of self-efficacy or action planning (Strategy, Intervention Design (Support), Self-efficacy).
- Support the tracking of additional health-related information (Intervention Design (Support), Illness, Functionality, Utility).
- Provide some example activity goals relating to age, weight, or fitness level but emphasise that these are guidelines and should be tailored to the indiviudal (Strategy, Intervention Design (Support)).
- Provide more adaptive goal setting functionality, including the specificity at which users can set and review goals (Functionality, Utility).
- Offer graphical feedback to show the progress of an individual (Functionality, Utility, Feedback).
- Build in interoperability with other apps (Functionality, Utility).
- Support interaction with other users of the DBCI (Other Users (Support), Functionality, Social, Interactivity).

10.4.3.4 Desired Behaviour and Feedback

In stage 1 Cara suggested that she would be likely to forget to return to the DBCI if she didn't receive a reminder or had not achieved her goals. A few stage 2 participants also mentioned not returning when they knew that they had not completed their goals.

> 'I didn't go in because I didn't achieve them' - *Christoph*, 26 (Stage 2)

This highlights an interesting relationship between the behavioural and digital factors: not achieving behaviour change goals (behavioural disengagement), would result in the non-usage of the intervention (digital disengagement). This is potentially problematic because this is precisely when a user may need the most support.

A failed attempt to be more active can affect an individual's self-efficacy and motivation, especially for participants with a low starting level (Hardy III, 2014, p.157). A failed attempt can therefore be a critical point for individuals during their behaviour change process, as they may require additional support or guidance. Feedback is also necessary at this stage because it helps the individual assess – and potentially alter – their approach and effort level (Michie *et al.*, 2014a, p.151). However, this feedback and support cannot be provided if the individual does not log back into the DBCI.

To try and encourage participants to log their activity, Getting Active used a simple gamification feature, which awarded a gold star on the successful completion of a goal. However, many participants either did not know about this feature or did not see the stars.

> 'I wasn't aware of being awarded stars, no' - *James*, 33 (Stage 2)

This gamification feature therefore did not entice participants to return to the system. It would be easy to explain this feature earlier in the process to encourage participants back onto the site. In addition, it might be beneficial to highlight areas of the site which aim to help individuals get back on track after failing to achieve a goal, such as the 'overcoming setbacks' pages.

10.4.3.4.1 Summary and Recommendations

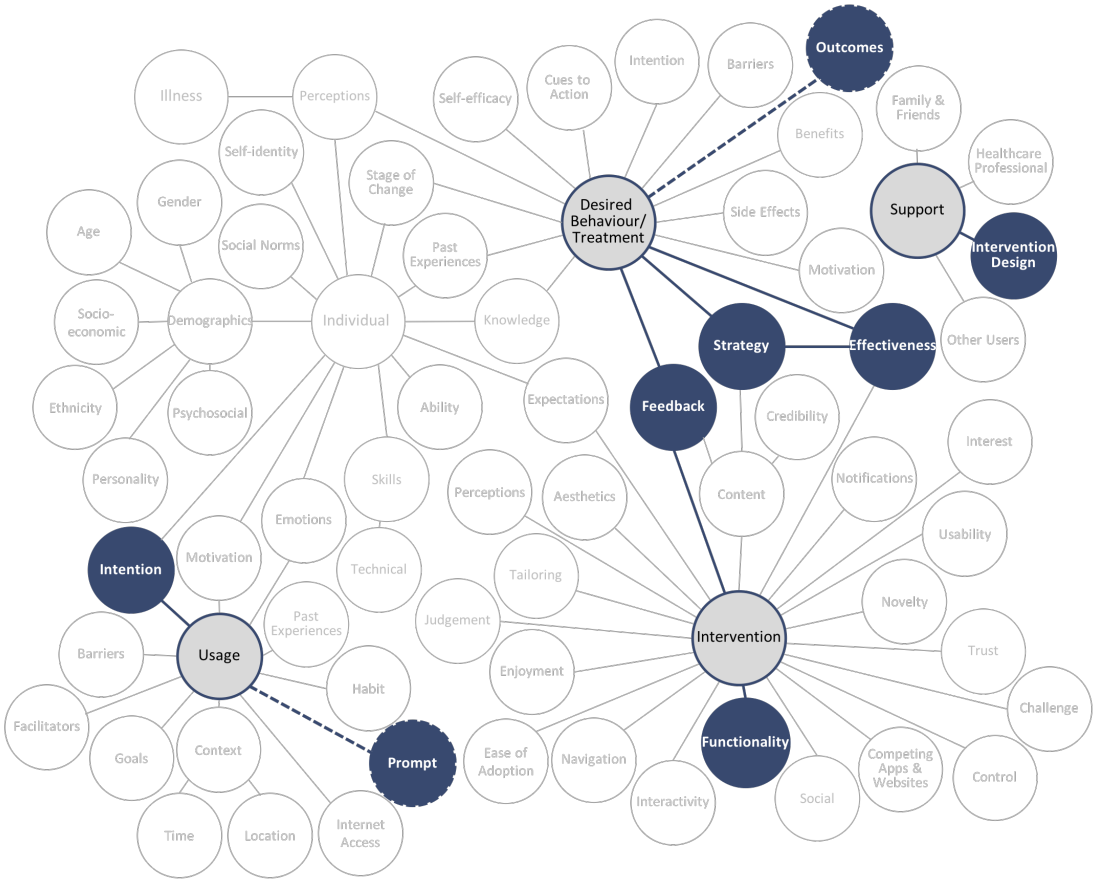

Figure 10.28: The DisENGAGE factors relating to 'Feedback' from Getting Active

Participants raised a number of factors that might affect their intention for future use, including the effectiveness (or more specifically the outcomes) of their behaviour change

attempt, and whether they received prompts from the system (see Figure 10.28). If users do not achieve their goal they are likely to need additional feedback and potentially need to alter their strategy.

The following recommendations present some of the ways in which the intervention design and functionality could offer this support.

- Explain the star feature during the goal setting process (Content, Strategy, Feedback).
- Consider additional ways to entice participants back to review their goals (Interactivity, Functionality).
- Move the 'overcoming setbacks' page to be more prominent within the DBCI design (Navigation, Layout).

10.4.3.5 Competing Apps & Websites and Ease of Adoption

There are numerous activity trackers on the market and many of these – including Fitbit – set goals to try to encourage users to be more active. The majority of stage 2 participants discussed using similar health apps and websites. For example, Lena used Fitbit, MyFitnessPal, and Strava and explains that Getting Active just did not compare.

> '[Would you actually use it?] Honestly, no, not compared to ... not compared to the other things out there' - *Lena*, 27 (Stage 2)

Multiple models from the HCI literature explain that a user will judge an intervention against other apps and websites (see 'personal standards' from Hassenzahl's (2005) 'Model of User Experience' (MoUE), 'choice of alternative' from Thüring & Mahlke's (2007) 'Components of User Experience (CUE) Model', and 'output quality' from Venkatesh & Bala's (2008) TAM3).

It is therefore important that an intervention designer considers what an intervention offers over other existing products. For example, Getting Active offers asthma-specific content which is not offered by these alternatives. Getting Active will also be part of a larger intervention, which would bring additional value.

If the overall aim was to increase the participant's activity levels then the intervention designers may be happy for these competing apps to be utilised. However, competing apps may not contain the appropriate behaviour change support nor strategies that are required to help an individual successfully change their behaviour.

If a user decides to select Getting Active over other options, these alternatives will still influence the participant's expectations and desired functionality. These comparisons may be subconscious (Schwarz & Schwarz, 2014, p.6) but will still determine their

judgements, expectations, and recommendations for the DBCI. Therefore it is important to understand these alternative apps and websites.

> '[iPhone Health app] that has like you know the different bits you can go into and it does like you know your like walking activity, it measures that, but you can input information, so that has got like different colours and it's got like different icons [...] that's quite attractive to look at, and it makes it easier to, I don't know, it makes it easier to navigate [...] Because you have to follow the colour, or you follow the picture' - *Becky*, 36 (Stage 2)

Individuals will also judge an intervention according to how easy it is to adopt, taking into account their lifestyle and current app usage. Many behaviour-specific apps are designed with interoperability in mind; the ability for systems to interact with one another. For example, Fitbit is designed to share data with MyFitnessPal or the iPhone Health app. This means that users do not have to manually enter or duplicate data. Getting Active does not currently offer this functionality and this was requested by a number of participants to ease adoption. Some of these features have other considerations – such as data protection and privacy – which would need to be considered.

> 'Having more interaction in terms of it working with other devices, at the moment it's standalone, it doesn't connect to my phone, it doesn't connect to my watch. That would help ... engage more with it' - *Christoph*, 26 (Stage 2)

Several stage 2 participants also desired automatic tracking and logging of activity, either by linking Getting Active with a worn device – like Fitbit or a pedometer – or by integrating Getting Active with a tracking app. Many participants did not want to manually type in their activity and these competing apps and websites have created an expectation that this can be achieved by an automatic process.

> 'Well the Fitbit ones more automatic so you don't have to manually put in what you've done and sort of click a button so it's much easier in that kind of way' - *Fraser*, 32 (Stage 2)

Participants also thought the 'web' format – as opposed to an 'app' – effected their ease of adoption.

> 'I think because it's a web platform it's a little harder, for me [...] I think if it was an app format that would be even more easy to use, like it would be on the front screen of my phone' - *Katie*, 34 (Stage 2)

10.4.3.5.1 Summary and Recommendations

Similar apps and websites are likely to influence users in a number of ways (see Figure 10.29). Participants will compare these products to see which they intend to adopt. In addition, these comparisons will mould a user's expectation of the DBCI, their desired functionality, and their judgement of the intervention. It is therefore important that a designer identifies the 'unique selling point' of the DBCI and ensures that it has additional value. Ease of adoption will also impact this process.

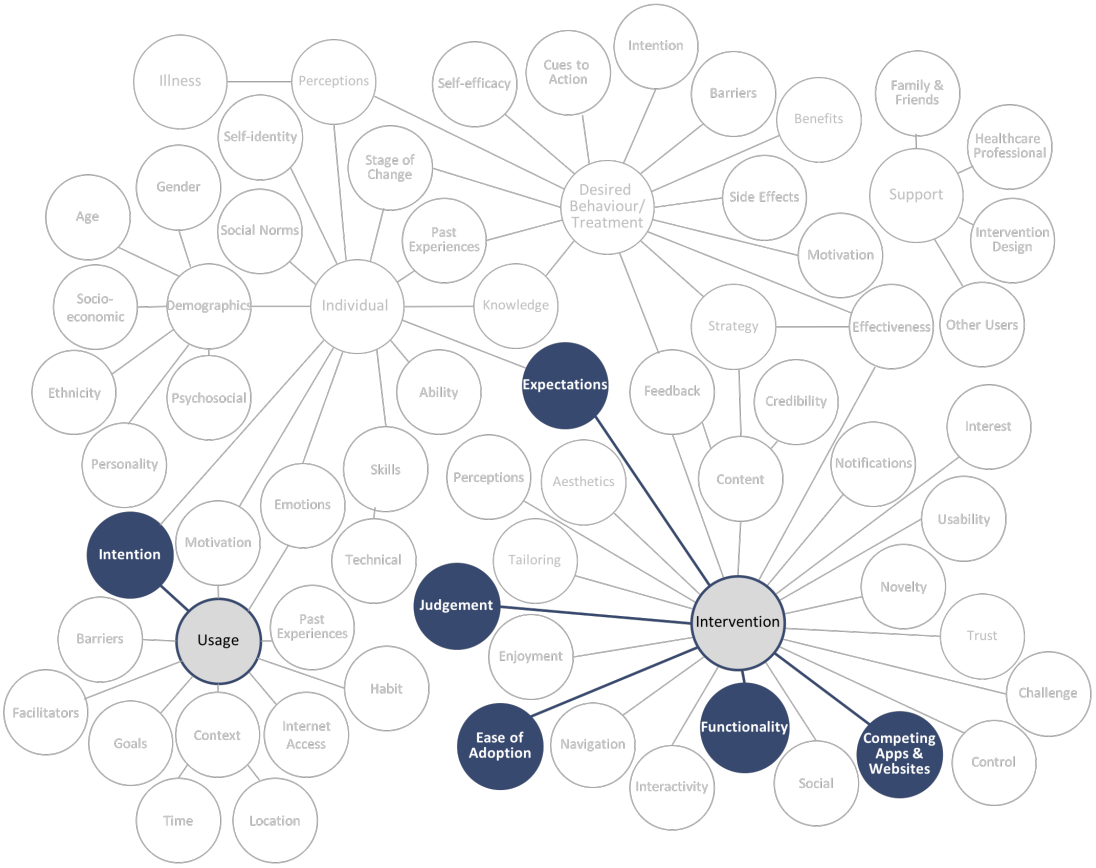

Figure 10.29: The DisENGAGE factors relating to 'Competing Apps & Websites' and Getting Active

The following recommendations should help to encourage the adoption of Getting Active over other less theory-based alternatives.

- Consider the other apps/websites on the market and think about whether Getting Active has a 'unique selling point' – this will take into account utility and functionality (Competing Apps & Websites, Functionality, Utility).
- Implement additional health-related tracking, such as recording peak-flow or medication (Intervention Design (Support), Illness, Functionality, Utility).
- Introduce reminder system for taking medication (Notifications, Illness, Intervention Design (Support), Functionality, Utility).

- Integrate with social media networks (Social, Other Users (Support), Interactivity).
- Explore and implement other forms of notifications (Notifications).
- Create a social network between users to offer support and encouragement (Other Users (Support), Functionality, Social, Interactivity).

10.4.4 Methodological Reflections

This section explores some of the limitations and methodological reflections that should be considered in light of this analysis.

10.4.4.1 Demand Characteristics

There were a number of instances where participants' behaviour conflicted with their verbal feedback or where they contradicted themselves during the course of the interview. This particularly happened when comparing the real-time feedback during the think-aloud with the follow-up questions at the end of the think-aloud interview. Although there were some explanations in design, it is also possible that this was a result of 'demand characteristics'. Research suggests that their true role within a study is to identify the purpose of the experiment and provide the data which supports the researcher's hypothesis (Orne, 1962, p.779).

During the real-time feedback of the think-aloud section, a participant does not have time to filter or sensor their comments and therefore demand characteristics have less of an impact. This is one of the reasons think-alouds are used for usability issues (Jaspers, 2009, p.345). However, when participants were asked follow-up questions they had time to consider their answer and possibly consciously or subconsciously alter their feedback.

Demand characteristics might also account for the conflicting comments in the retrospective interviews. Participants wanted to answer truthfully but also wanted to answer 'correctly' – providing the kind of response that they thought the researcher wanted to hear. For this reason, participants were told at the start of the stage 2 interviews that the interviewer was not the designer of the DBCI and therefore would not be offended by their feedback. This seemed to have an impact on their responses and was highlighted by the fact that one participant was informed about this fact after a few introductory questions and became more opinionated and negative after receiving this information.

This was also highlighted by the change in response to the future usage question. The follow-up question received a less 'desirable' response. It is possible that the repetition led participants to think that they needed to change their answer. However, the supplementary responses were less positive and therefore participants were probably aware

that this was unlikely to be the outcome that the interviewer wanted. Furthermore, the second response was supported by other comments made within the interview.

Finally, demand characteristics seemed to impact the usage logs. A number of participants set *easy* goals or goals they already planned to complete and would easily achieve and mark as *complete*. Analysing this usage would have led designers to believe that the DBCI had had a positive impact on these participants. However, these users had not actually increased their activity levels; they were just using the system because that is what they thought they should do. This usage data would mislead researchers about the success of the intervention. This could be true with other completion measures used in behaviour change research studies – such as login count, time spent on page, or specific use of features – and therefore it is important to have qualitative data to contextualise the DBCI usage.

10.4.4.2 Think-aloud vs. Retrospective Interviews

There was a difference in the type of data collected through the think-aloud and retrospective interviews. The think-aloud interviews seemed to focus on usability and navigational issues, including the emotional reactions of the users. In contrast, the retrospective interviews highlighted the real-world usage and reactions to the goal setting feature. However, each method fulfils a different purpose.

The think-aloud data provided data about the user's emotional reaction to using the system. Participants clearly struggled with usability issues and appeared to become frustrated by them. This relationship between negative emotions and poor usability is well documented. In fact Rubin & Chisnell (2008, p.4) explain that frustration and usability are strongly intertwined – stating that something is 'usable' when there is an 'absence of frustration'. More generally, usability issues are a concern because research shows that they affect DBCI adoption (Brown III *et al.*, 2013, p.1081).

However, it is important to remember that users are new to the system and some of the confusion may be a result of 'learnability'. Learnability refers to the learning curve which a new user follows when they are familiarising themselves with a new system (Tullis & Albert, 2013, p.92). Some of the confusion therefore may be due to learnability and once mastered may not impact the user's experience. However, this data is still valuable because there may be ways a designer can reduce the learnability effort, either through better signposting or additional visual cues. Furthermore, a designer can combine think-aloud findings with the retrospective interview and usage data to identify which issues have remained a problem.

In addition, using a combination of the think-aloud and retrospective approaches provides data for different aspects of disengagement. Think-aloud data can help to understand how a user first perceives the DBCI and what their experience is like using it for

the first time. However, this data cannot show how a user will use the intervention in the real-world or whether it will help them achieve their behavioural goals. Therefore, think-aloud data can help to identify early digital disengagement factors, which provides guidance for the next stage and helps researchers plan their disengagement data collection. As a result, the retrospective data can provide valuable digital and behavioural disengagement factors.

10.4.4.3 Usage Logs

Combining usage and qualitative data – through methodological triangulation – also identified some discrepancies in the usage data. It appeared that some sessions had not been logged into the system. This affected the utility of the usage logs, preventing some forms of analysis. However, this usage data still provided invaluable insight into the participants' usage and patterns of interaction. Furthermore, it provided context to create tailored interview questions, which helped lead to a more comprehensive understanding of the participants' usage.

This usage data discrepancy also highlights the importance of validating usage data especially as it is often used as the basis of engagement research.

10.4.4.4 Summary: Methodological Reflections

Mixing methods provided a number of insights into disengagement which may not otherwise have been identified. Demand characteristics can be a problem in any research study, but informing the participant that the interviewer was not the designer appears to have reduced the influence of this bias. Furthermore, repeating a question in a slightly different format seemed to also affect the response provided by the participant.

The think-aloud and retrospective interviews appear to have highlighted different aspects of the user experience. It is important to remember the limitations of each data collection method. For example, the think-aloud may be overemphasising the significance of certain usability issues. However, by combining the findings of each method it is easier to identify the areas of the design which should be focused upon. It also helps identify any slight discrepancies in the data.

10.5 Summary and Discussion

This analysis has highlighted numerous factors that can affect an individual's use of the DBCI and behaviour change attempt (see Figure 10.30). Each factor identified in

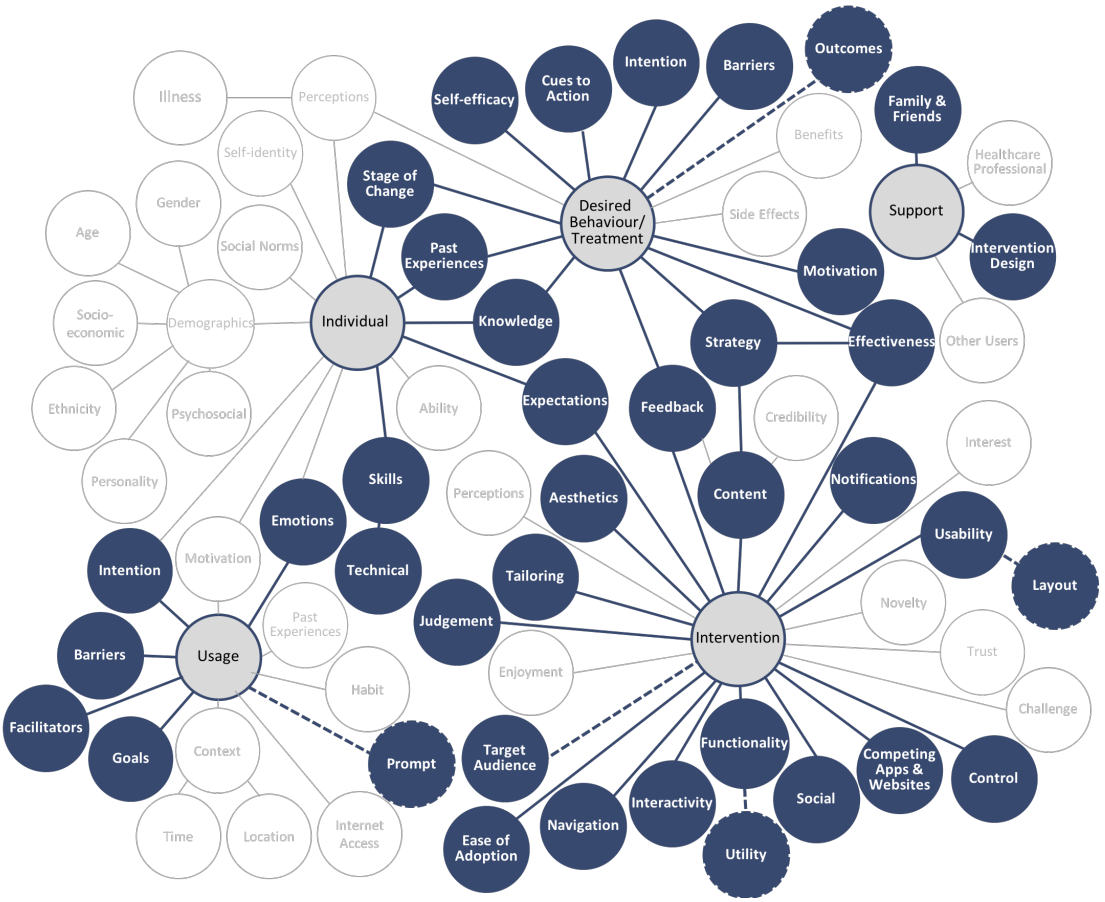

Figure 10.30: The DisENGAGE factors identified within the Getting Active case study that may lead to disengagement

this analysis had an impact on several other framework factors, showing the need for a holistic exploration of usage and disengagement.

This analysis also highlighted several barriers that would directly result in these participants disengaging from the DBCI. However, the collected data (using the framework) also provided practical implementable recommendations which can help increase the utility of the DBCI and support these individuals in their behaviour change attempts.

This disengagement study followed two stages. Stage 1 involved six participants who followed a think-aloud method in a lab setting. These were thematically analysed – producing a think-aloud codebook – to provide insight into the user experience and guidance for stage 2 retrospective interviews. Stage 2 involved 13 participants who used the intervention for a minimum of two weeks before taking part in a semi-structured interview. The retrospective interview data was also thematically analysed and this was combined with the usage data to identify factors that led to users disengaging from the Getting Active DBCI.

The retrospective interviews also highlighted an issue with the usage data logs; the intervention was not successfully recording every session. Exploring the data set identified

a few sessions which were unlabelled and these could be correctly attached to one of the users. However, there appeared to be some additional sessions which were not recovered or recorded. This is an important consideration for studies that use usage data without any additional validity checks.

There were several interesting themes that emerged from this case study and this chapter has focused on the themes that specifically led to disengagement or highlighted important considerations for disengagement research. The DisENGAGE Framework encouraged the collection of data regarding the user, their illness, activity levels and feelings about the intervention. Understanding the larger contextual environment in which the user was using the DBCI has provided a number of interesting insights into why participants disengaged from the intervention.

Usability, aesthetics, section labels and navigational issues cause a number of problems for stage 1 and 2 participants. These can cause frustration and have a negative impact on the user's experience with the intervention. In addition, these navigational issues in combination with layout choices resulted in a number of users missing sections of the intervention. Some of these areas, such as the safety aspects, are important but also offer information and guidance which are not always provided in alternative apps or websites. This usability issue could be removed or reduced by editing the navigational structure or user interface.

Notifications impacted the users in two ways. Firstly, prompting users to log back into the DBCI. This relationship between prompts and usage is not easily traceable through the LifeGuide software. Secondly, emails reminded users of their behaviour change goals or actually encouraged them to go and be active. This type of relationship between emails and action is not trackable through usage logs. There are a number of ways that this feature could be made more effective to support activity further, such as scheduling in sessions and sending emails at relevant times to nudge the individual to stick to their plan.

There were multiple factors that related to the individual's likelihood of future DBCI usage. Interviewing the participants helped to understand their motivation for being in the study. Some participants appeared to be trying out the intervention for the study with little intention of being more active. This was highlighted by the setting of easy goals which the users already knew they were going to complete. Other participants appeared to be using the system for the study but actually did have an underlying desire to be more active. These participants identified a number of barriers to activity which were irrespective of their asthma but the intervention did not meet their requirements. As a result, users requested additional functionality including more specific goal setting options, interoperability with other apps, or additional tracking options, all of which would make this intervention more valuable to potential users and reduce the likelihood of digital disengagement.

This analysis also highlighted the importance of understanding which competing apps and websites the user is already engaged with or has the ability to obtain. These apps or websites in a way compete with the intervention and therefore the designers need to be considering what the intervention offers that is unique and more appealing or useful than these other options. In addition, these app and websites create expectations of use and quality, which the intervention will be judged against. This can affect the the user's overall experience and impression of the site and ultimately affect adoption.

The study has also highlighted the different types of data collected by think-aloud and retrospective interviews. The think-aloud interviews provided important user experience data, including usability issues and emotional reactions to the intervention. On the other hand, it also highlighted some issues which may have resulted from the learnability curve, rather than from a genuine usability problem. The retrospective analysis provided a better understanding of the real-world usage, including triggers and overall impressions. It also provided data regarding how the user utilised the features that were available to them.

Chapter 11 will present the updated framework, based upon the previous literature review and the findings of this study.

Chapter 11

The DisENGAGE Framework 2.0

The case studies have shown how the DisENGAGE Framework can be used to better understand disengagement from various DBCIs. This chapter presents the newly updated DisENGAGE Framework 2.0, explaining how the case studies have helped refine the tool to increase its usability within a research study.

Section 11.1 introduces the DisENGAGE Framework 2.0 and its updated categories. This section also explains a few additional factors that were identified during the third case study. Section 11.2 explains how the framework should be used within disengagement research. Finally, Section 11.3 shows how the tool can be used within a pre-existing DBCI development process such as the 'Person-Based Approach' (PBA) (discussed in Chapter 2). Chapter 12 will then explore some of the disengagement themes that have emerged across the three case studies.

11.1 Categories

This section presents the new DisENGAGE Framework 2.0 (see Figure 11.1), which has evolved from the original DisENGAGE Framework to include the findings from the Getting Active disengagement study (Chapter 10). The original framework (see Figure 11.2) was presented in Chapter 6 and emerged from a critique of the Behaviour Change and HCI literature. The DisENGAGE Framework 2.0 continues to contain all the factors from the original framework but these have been reconfigured and additional factors have been included. The following sections present the updated categories.

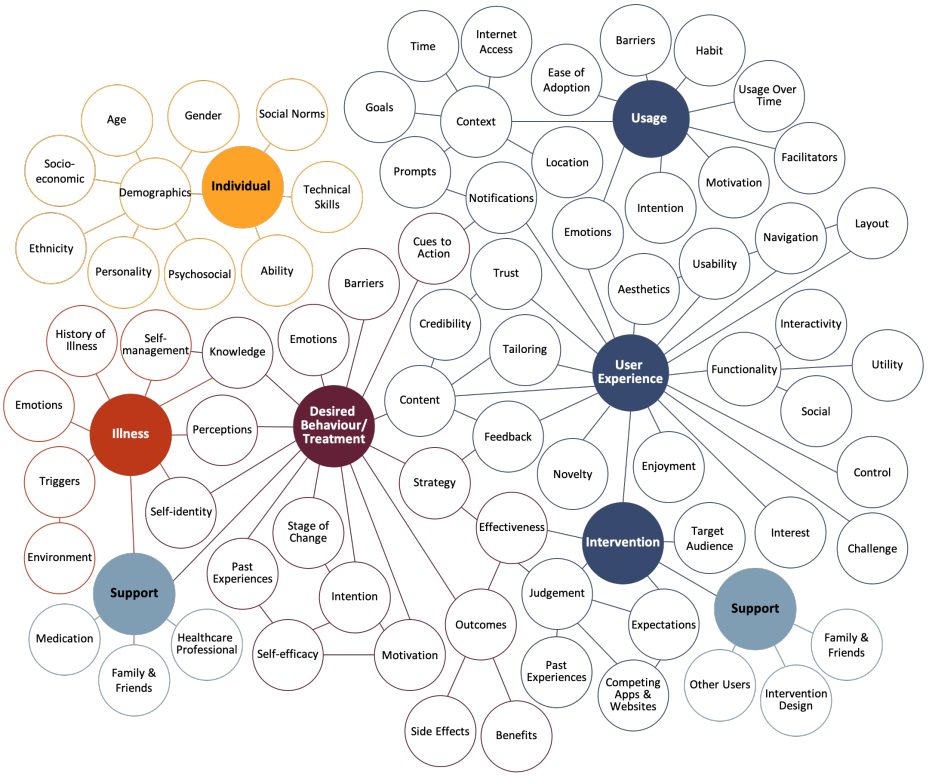

Figure 11.1: DisENGAGE Framework 2.0 (Coloured by category)

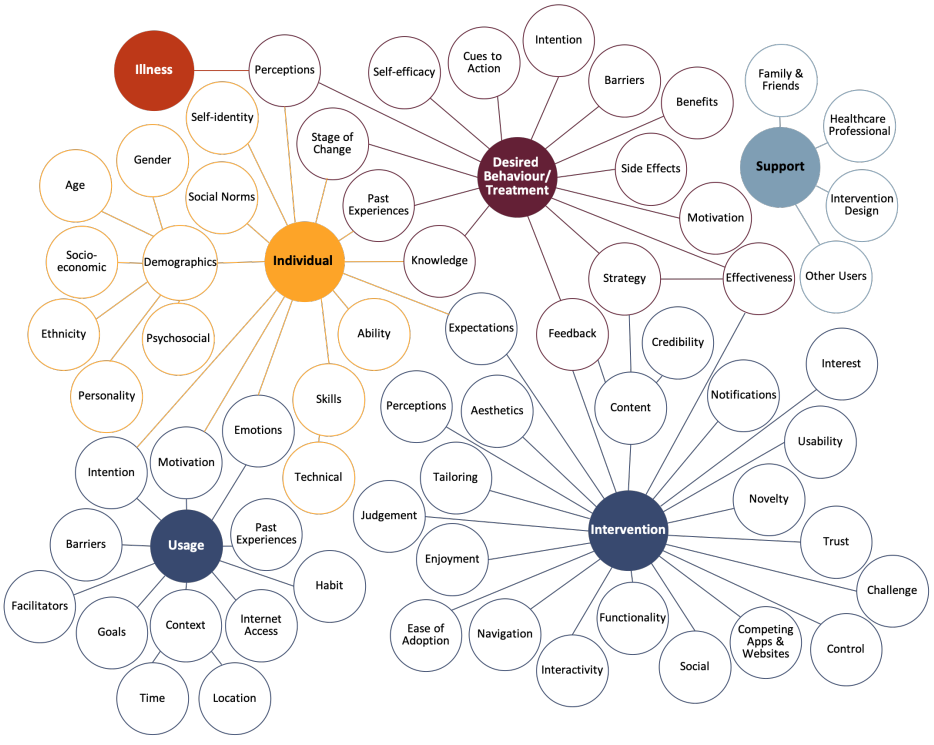

Figure 11.2: DisENGAGE Framework 1.0 (Coloured by category)

11.1.1 Individual

The original DisENGAGE Framework connected the 'individual' to various factors relating to the 'intervention', 'desired behaviour/treatment', and 'illness'. These factors – such as 'perceptions' and 'emotions' – were specific to each individual and therefore were categorised accordingly. However, 'emotions' are contextual and it is more relevant to consider the subject-focus of the emotion. For example, many participants became frustrated when using the intervention due to their 'user experience' – involving factors such as 'usability', 'navigation', and 'aesthetics'. For this reason, several of the factors have been moved to their subject focus rather than their origin, factors such as the 'emotions' felt about their 'illness' or about their 'desired behaviour/treatment'. Figure 11.3 highlights the various user factors that have been relocated for DisENGAGE Framework 2.0.

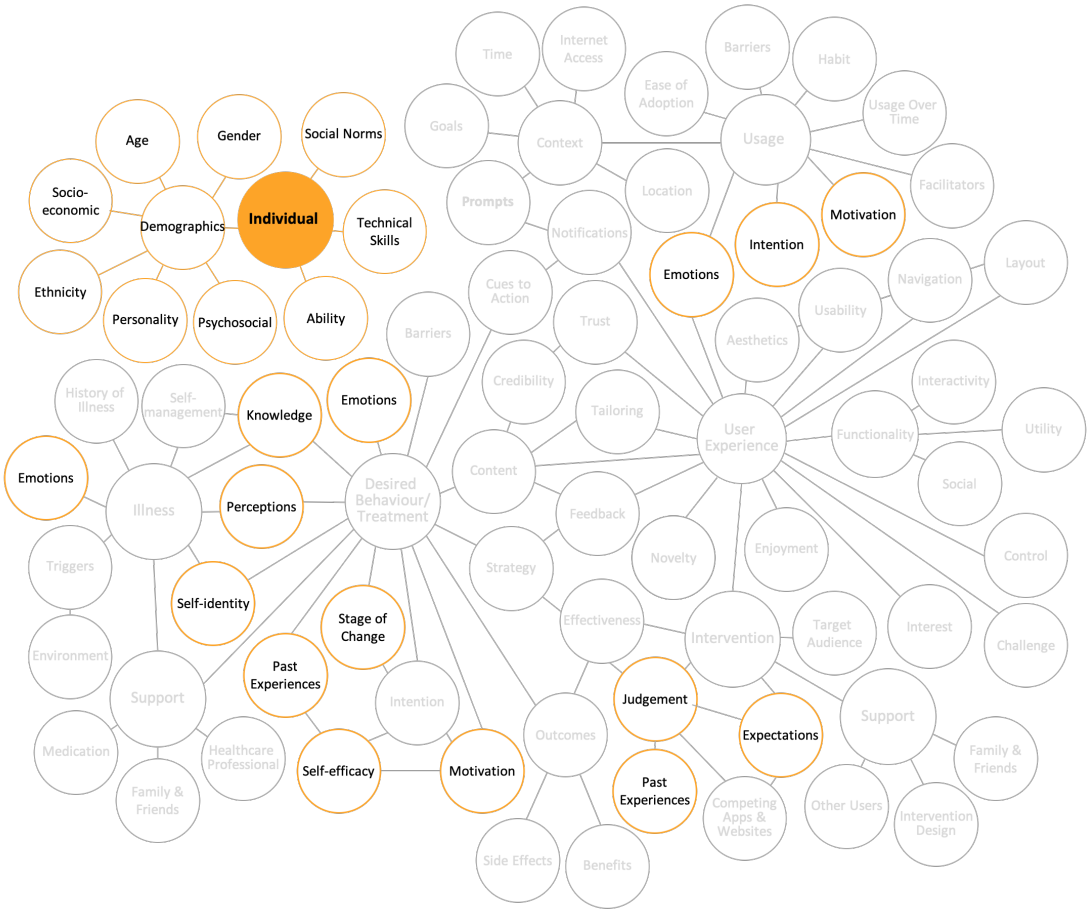

Figure 11.3: DisENGAGE Framework 2.0 with the original 'Individual' factors highlighted

Grouping factors according to their subject-focus also helps the process of thematic analysis. Categorising data according to the subject (or category) and then the specific factor ensures that the data point will not lose its context, which for some factors – such as 'emotion' – is critical. This will also hopefully encourage researchers to collect data relating to each of the contexts or categories rather than just one. For example, a negative emotional reaction to the 'desired behaviour' will impact the individual's behavioural 'outcomes' and the likelihood of DBCI 'adoption'.

There are some 'individual' factors that are not directly linked to the other categories but instead can influence the entire process. For example, 'age' may impact an individual's 'illness', their ability to carry out a 'desired behaviour/treatment', and the 'support' they require to use the DBCI. These factors work in a similar way to the 'modifying factors' from the Health Belief Model (HBM) and researchers should be aware of them during any disengagement data analysis (see Figure 11.4).

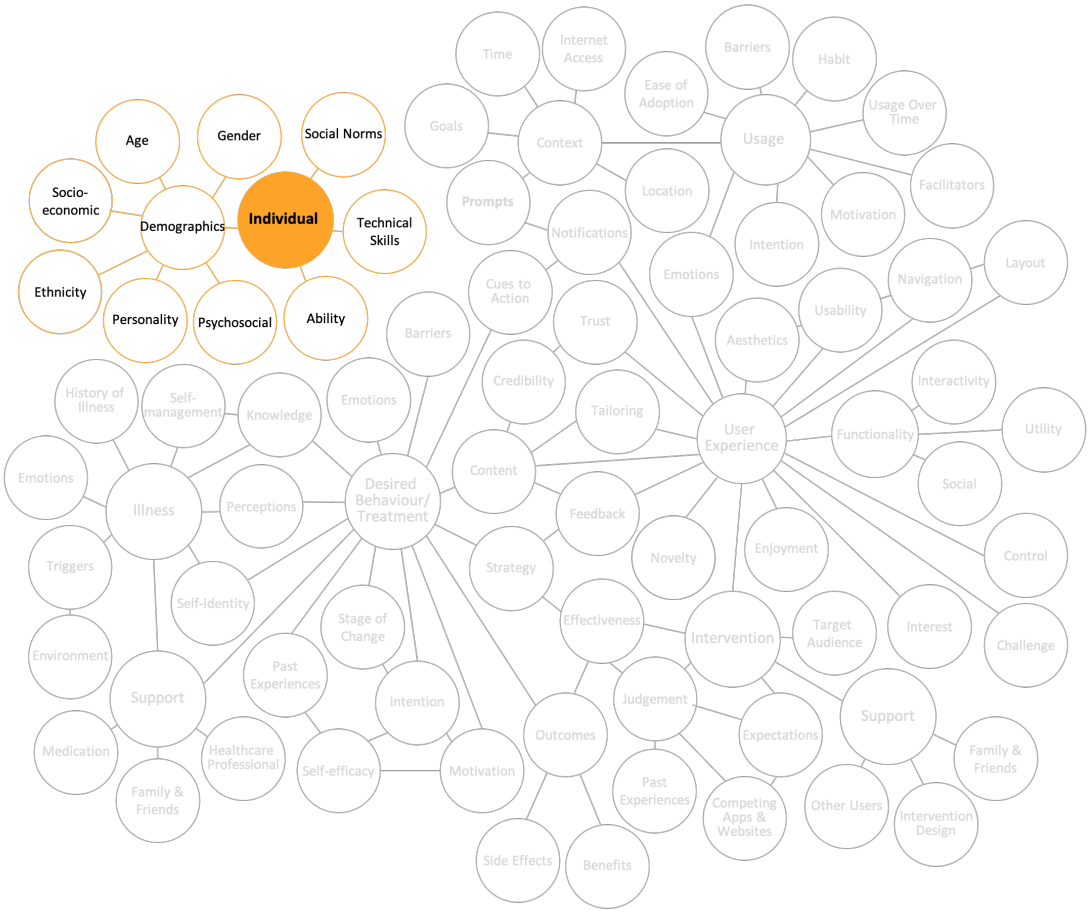

Figure 11.4: DisENGAGE Framework: Individual 2.0

11.1.2 Support

Support is another highly contextual category, either relating to the 'intervention', 'desired behaviour/treatment', or the 'illness'. Participants in the Getting Active study requested additional support or guidance during the goal setting process. A DBCI may be taking the place of a healthcare professional and therefore it is important that individuals feel supported during this process.

Some Getting Active individuals also discussed the idea of a network of users which would offer support through the intervention. In addition, many participants talked about the support they received or required in managing their 'illness' or during their behaviour change attempts ('desired behaviour/treatment'), often from 'friends and family'. Although these different situations all refer to the general idea of support, they are context specific and the type of support takes slightly different forms. This is reflected in the updated framework (see Figure 11.5).

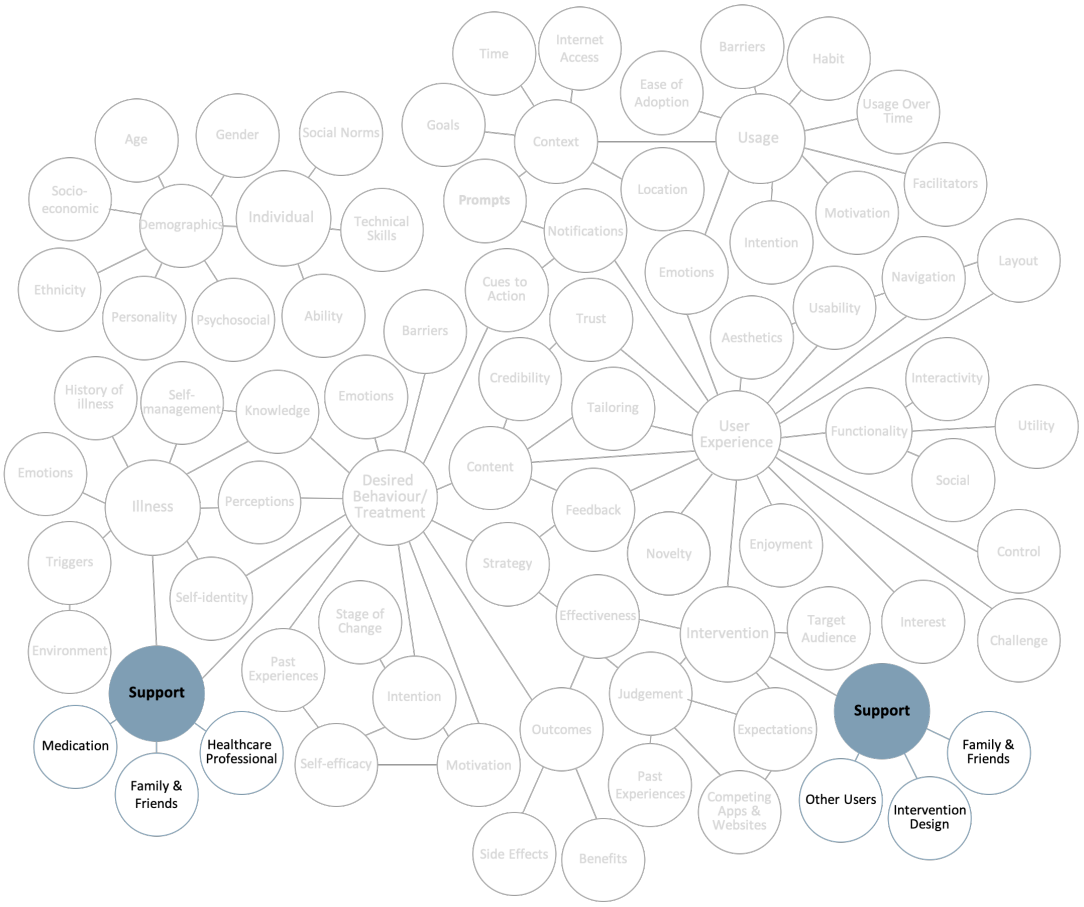

Figure 11.5: DisENGAGE Framework: Support 2.0

11.1.3 Intervention

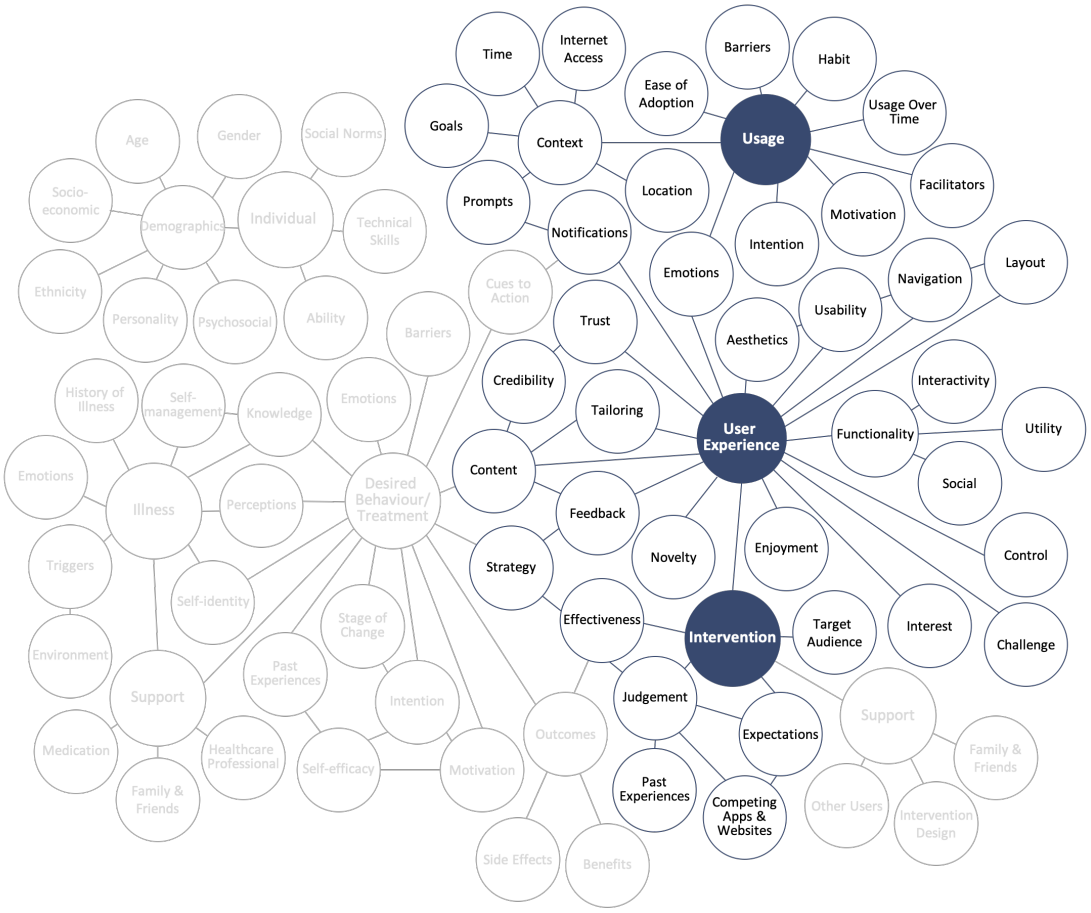

Figure 11.6: DisENGAGE Framework: Intervention 2.0

The original framework separated DBCI factors into 'intervention' and 'usage' to reflect the spatiotemporal nature of 'usage' factors. However, during thematic analysis it was useful to add an additional sub-category: 'user experience'. As a concept 'user experience' is difficult both to define and to operationalise. The use of this term as a sub-category is to encourage researchers to also ask broader questions relating to an individual's experience of use, especially because this is not an exhaustive list. The Getting Active participants highlighted a number of 'user experience' related factors including 'usability', 'aesthetics', and 'navigation'. In addition, it became apparent that these different factors are closely linked and were further influenced by 'layout' – a factor that has been added to the DisENGAGE Framework 2.0 (see Figure 11.6).

The 'context' factor of usage was also extended to include 'prompts'. Many Getting Active participants were prompted to use the DBCI by a Getting Active email. However, this 'prompt' might take different forms, such as walking past the gym, or glancing at a pedometer.

The 'functionality' factor was part of the original framework. However, the Getting Active research highlighted that the functionality being offered by the DBCI may not match an individual's requirements. For example, the goal setting feature was clearly not versatile enough for many participants and this led to some disengaging digitally. For this reason, an additional factor – 'utility' – has been included. This ensures that data about 'functionality' (and whether it works) is collected, but also whether particular features are useful to the participants.

There was also an interesting relationship between 'competing apps & websites' and users' expectations regarding the DBCI. It was clear that some of the recommendations and 'expectations' were solely based on the user's experience with a similar product – such as Fitbit. In addition, a researcher needs to consider whether a DBCI offers additional benefits over other pre-existing products because an individual will 'judge' the intervention by these factors. This does directly relate to all factors of the 'user experience' sub-category.

It is also important to understand ideas around the 'target audience'. A number of participants in the Getting Active study listed several barriers to their behaviour change attempt, including simply *life*. It is possible that these individuals were not ready to commit to their behaviour change attempt and therefore were not the 'target audience' for this particular study. In this case, a lack of adoption or usage 'intention' may carry less weight than an individual who is committed to their behaviour change attempt but struggles with an aspect of the DBCI design, such as 'navigation'. Understanding these different elements will lead to a more holistic explanation of future usage.

11.1.4 Desired Behaviour

The desired behaviour factors did not alter drastically, apart from the re-categorisation of individual factors in order to align them specifically with this category (see Figure 11.7) and the addition of 'outcomes'. However, there was an interesting relationship in Getting Active between 'notifications' and 'cues to action'. Many of the participants explained that the notifications prompted their activity; a relationship that would not have been identified through the usage data alone.

The Getting Active study also identified that the effectiveness of the DBCI was not the only factor relating to usage and disengagement. Several participants explained that they did not return to the DBCI when they knew they had not completed their goals. Therefore the 'outcomes' of their behaviour change attempt had an impact on their digital disengagement. This goes beyond the 'effectiveness' of the intervention to include other factors which link to their attempt, such as 'side effects' and 'benefits'.

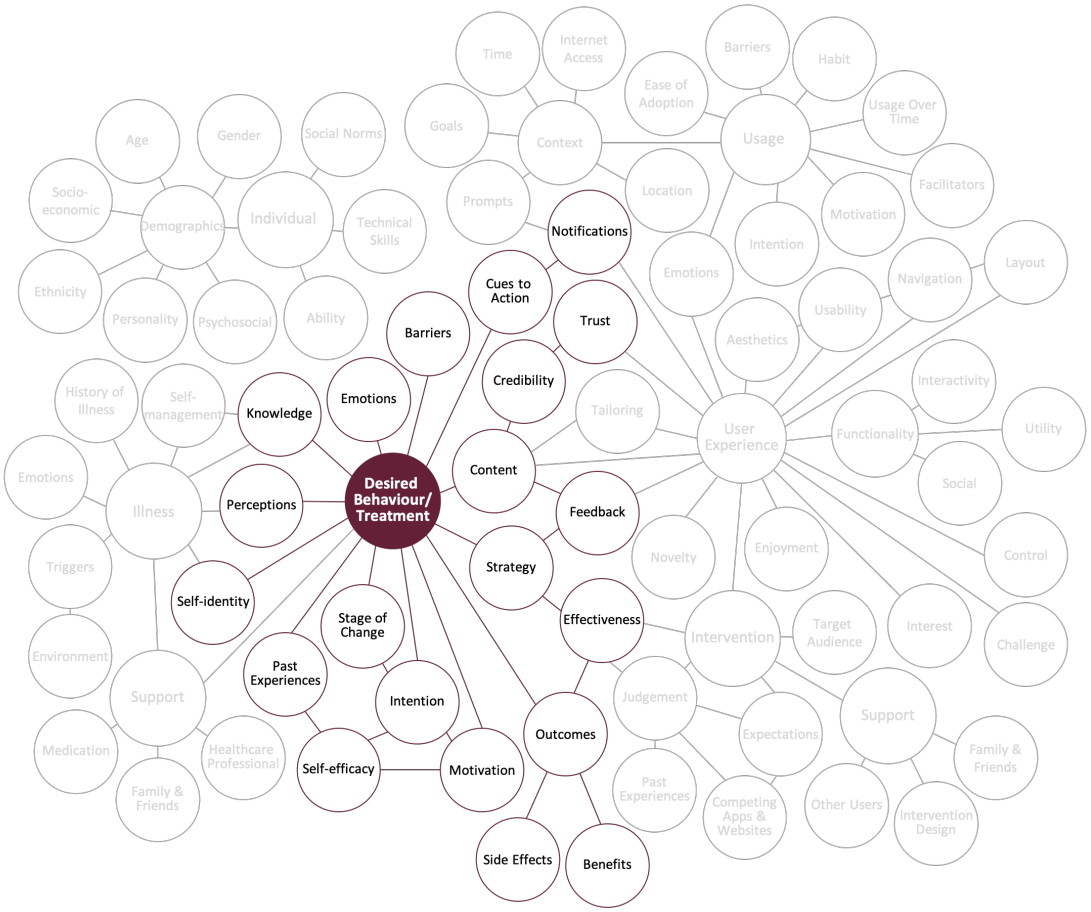

Figure 11.7: DisENGAGE Framework: Desired Behaviour 2.0

11.1.5 Illness

The 'illness' category was not a significant aspect of the original framework. This was partly because behaviour change attempts are not always directly related to an illness. For example, the Getting Active website could have been an intervention for anyone wanting to be more active, rather than specifically focusing on asthmatics. However, understanding an individual's illness – how they self-manage, what triggers their symptoms, and their history – can provide additional information to improve the 'utility' and 'effectiveness' of the intervention (see Figure 11.8). For example, understanding what a user knows about their illness and the desired behaviour might explain why the choose to engage (or not) with the content of the intervention. Furthermore, many of the Getting Active participants consistently forgot to keep their inhaler with them during the day; this often resulted in a bad asthma attack. The DBCI designers could consider a 'notification' function or reminder system to try to prevent this from happening, thereby increasing the 'utility' of the intervention.

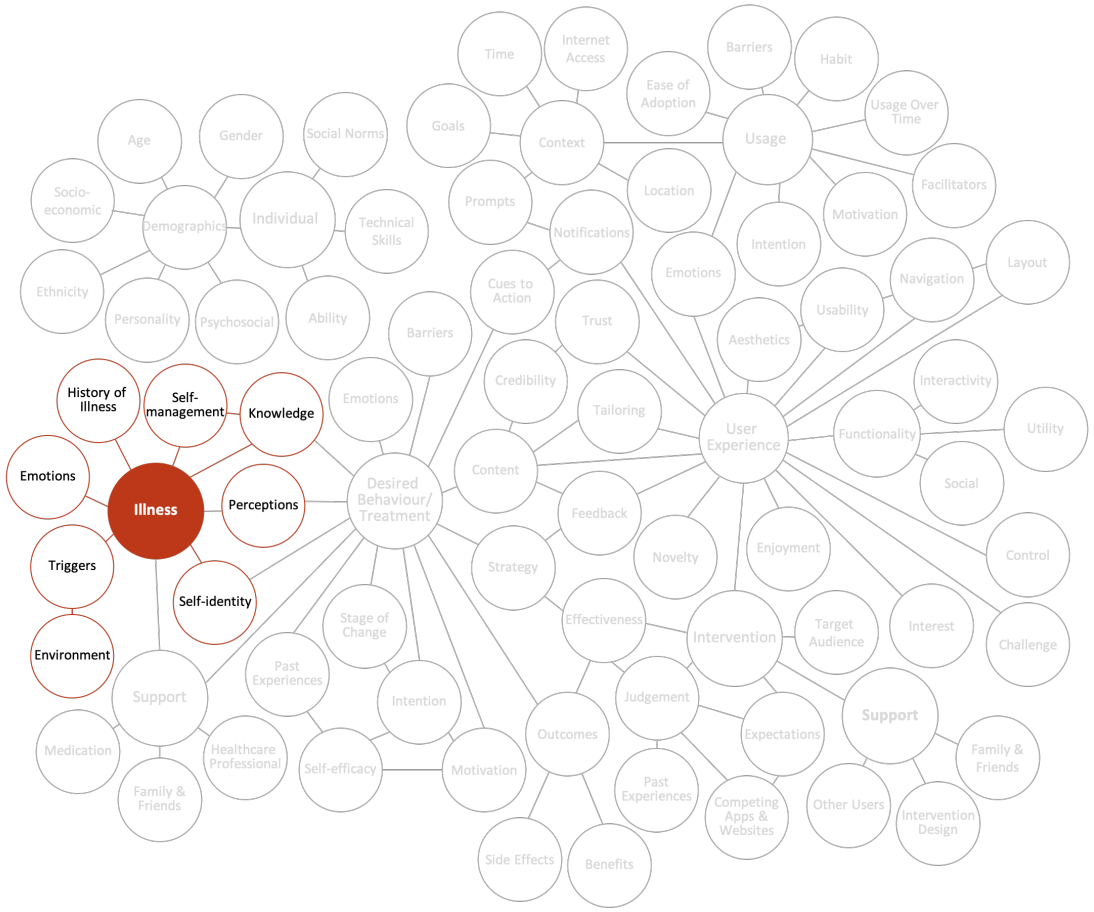

Figure 11.8: DisENGAGE Framework: Illness 2.0

11.2 Using the DisENGAGE Framework 2.0

The DisENGAGE Framework 2.0 should be used throughout every stage of the research process illustrated below (see Figure 11.9). Engagement is often a secondary research aim and therefore only considered after the data collection has been completed. In addition, many studies base their engagement analysis solely on the usage data. The various case studies have highlighted the limitations of this type of approach and how misleading these conclusions can be. Using this type of framework through the entire process ensures that the correct data is collected and that researchers can explore this phenomenon from a holistic perspective.

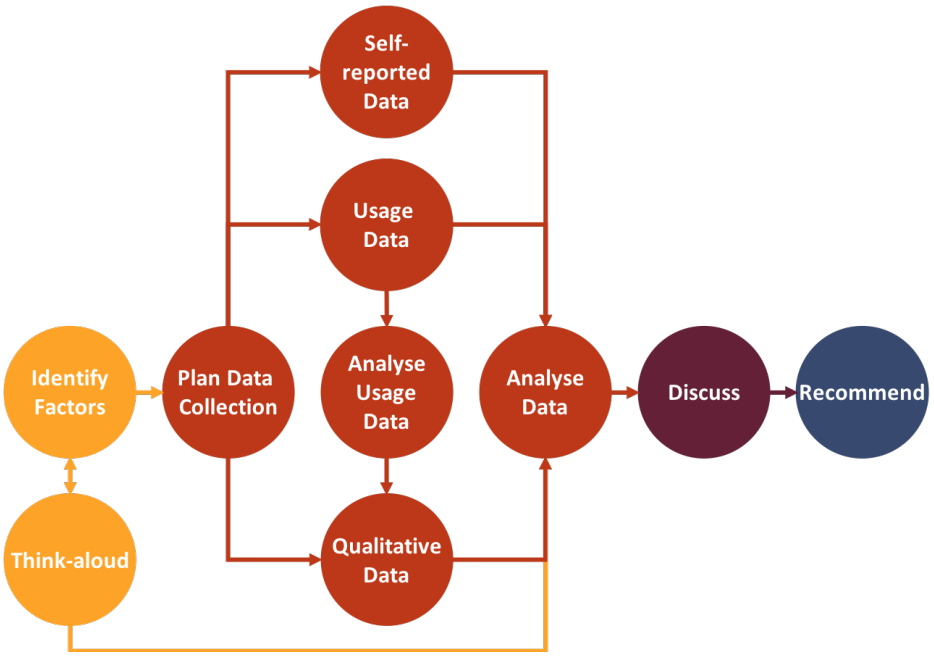

Figure 11.9: The stages of disengagement research which use the DisENGAGE Framework 2.0

11.2.1 Identify Factors

Before starting a new DBCI study it is important to consider the type of intervention and therefore the data points that will be relevant for exploring disengagement. For example, some DBCIs will not have an 'illness' directly associated with the behaviour change strategy and therefore it is more important to focus on the 'desired behaviour' factors. Alternatively, if the DBCI includes a large amount of personal data then 'trust' may become a primary consideration. Researchers should also think about the 'target audience' and whether there are any particular factors which need to be considered, such as 'age' or 'ability'.

11.2.2 Plan & Analyse Data

Collection and analysis have been grouped in the same stage because this process may be iterative. The analysis of usage (quantitative) data may influence decisions about qualitative data collection.

11.2.2.1 Collect Data

The identified disengagement factors will influence the data collection method. For example, the think-aloud method was more successful at collecting data relating to 'emotion' and certain 'usability' issues.

When deciding on the method it is important to understand its limitations and the impact that these might have on the validity of the findings. For example, a think-aloud method will not show real-world usage patterns or prompts. If the research project has the resources it is useful to use different qualitative methods at different stages, such as think-alouds and retrospective interviews.

In addition, the framework helps to identify factors for the qualitative data collection. For example, a researcher might want to understand what prompted the individual to use the DBCI or ask whether they intend to use it in the future. 'Competing apps & websites' can also have a strong impact on 'expectations', 'judgements' and 'adoption'; therefore researchers may want to understand how the DBCI fits into this wider context of use. The framework can therefore help to shape the interview guide.

11.2.2.2 Analyse Data

As a result of the mixed methods approach the data will be in two forms, qualitative and quantitative. The qualitative data (either from the think-aloud or retrospective interviews) can be thematically analysed. The DisENGAGE Framework 2.0 can also provide the starting point for a codebook (see Appendix F.3 for example codebooks). The volume of data can be overwhelming so it is easier to code data first in terms of its subject - 'intervention', 'individual, 'desired behaviour', or 'illness' - and then the categorised data can be explored. It can also be helpful to use sub-codes when there is a large volume of data. For example, 'navigation' may be divided into 'Confusing navigation' and then 'Have I been here before?'. These sub-codes will be study specific.

This process is neither deductive nor inductive. Researchers are encouraged to use the framework to identify potential disengagement factors but should not be limited by these. New factors may emerge based on new research into the 'illness', 'desired behaviour' or 'context' of use.

The quantitative data should be reviewed in conjunction with the qualitative data. It depends on the capabilities of the technology but most sites will collect a number of session-based metrics (see Section 7.3.4 for further information on quantitative analysis).

11.2.3 Discuss Findings and Make Recommendations

Once the data is analysed, researchers can start to draw connections between factors. The framework already highlights several related factors, but collecting and analysing the data using the DisENGAGE Framework 2.0 helps to focus the researcher on the important factors. In addition, it encourages the collection of behavioural and digital data to provide a holistic approach to disengagement research. Exploring and understanding

the relationships between various factors provides further insights into the DBCI usage; researchers can use these to write a list of recommendations (either for the current intervention or future projects).

11.3 Combining the DisENGAGE Framework with a DBCI Development Approach

As discussed in Chapter 2, there are numerous approaches to DBCI development. The DisENGAGE Framework 2.0 can be used with any DBCI, to better understand the users and their experience of use. It is a tool that can help evaluate DBCIs but it is imperative that it is used throughout the entire process to ensure that the required range of data is collected.

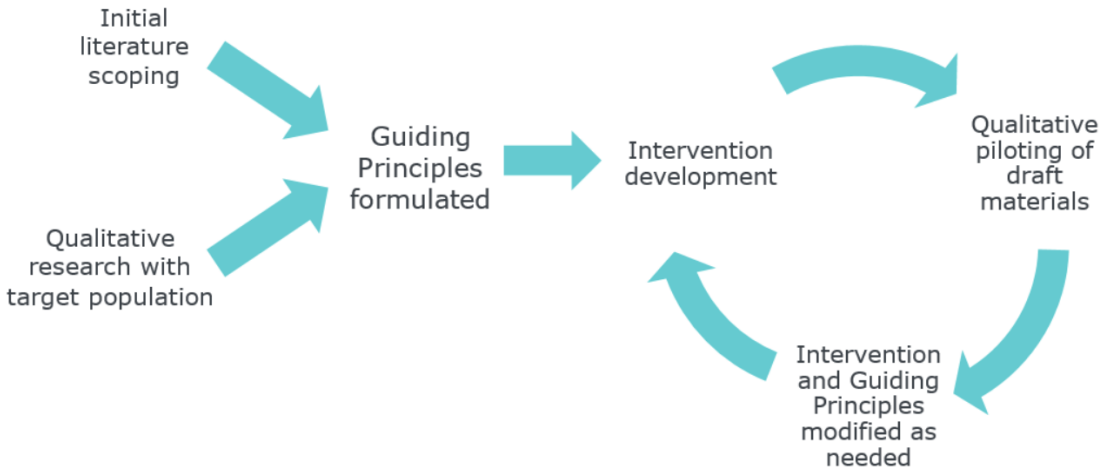

Figure 11.10: The 'Person-Based Approach Core Methods' taken from Yardley *et al.* (2018)

This section shows how the DisENGAGE Framework 2.0 can be integrated into the 'Person-Based Approach' (PBA) (see Figure 2.2). This approach aims to keep the individual who will use the intervention at the core of development (Yardley *et al.*, 2015). It aims to understand both their psychosocial context and individual perspectives in order to deliver an intervention that is fit-for-purpose (see Section 2.2.2 for more details). The PBA has been selected because it is theory-based and is meant to be used in conjunction with other approaches. In addition, both PRIMIT (case study 1) and Getting Active (case study 3) used the PBA so this example shows how they could have also utilised the DisENGAGE Framework 2.0.

Figure 11.11 illustrates how the stages of disengagement research using the DisENGAGE Framework 2.0 can be incorporated into the PBA during the development of a DBCI. This shows how a researcher can achieve their primary research objectives whilst at the same time collecting and addressing data about disengagement from the DBCI.

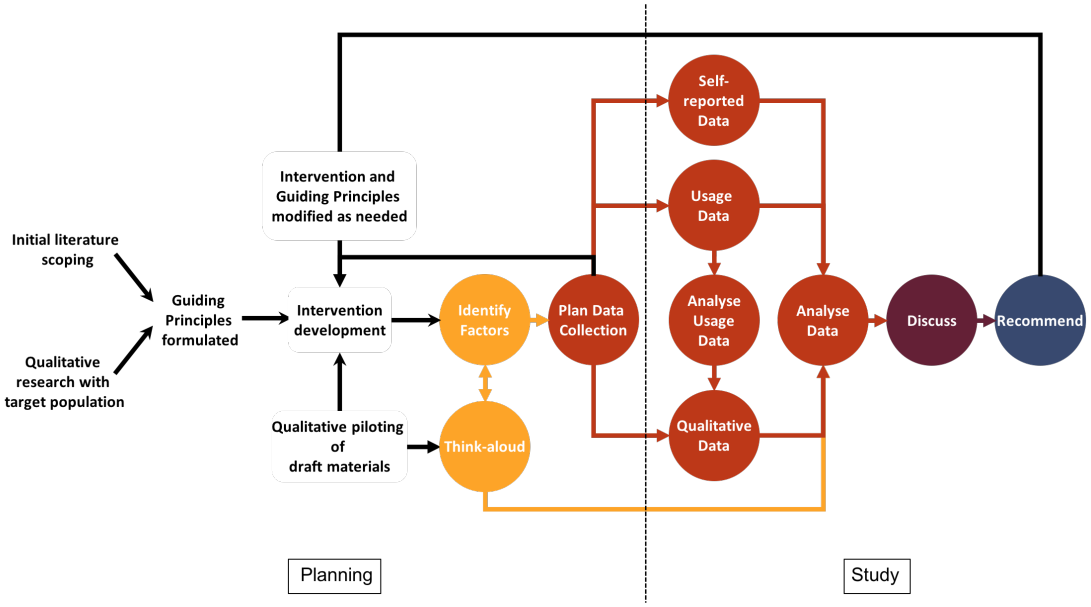

Figure 11.11: The stages of disengagement research that use the DisENGAGE Framework combined with the 'Person-Based Approach'

The 'identify factors', 'think-aloud', and 'plan data collection' are all carried out during the planning stage of the study. There is a link between the data collection planning and the 'intervention development' because the DBCI design can be adapted to capture certain types of disengagement data. The stages to the right of the dotted line signal the start of the study.

This is just a brief overview of a possible way in which these two approaches can be combined. However, the DisENGAGE Framework 2.0 can be used by any researcher within any developmental cycle to understand more about their DBCI and disengagement.

11.4 Summary

DisENGAGE Framework 2.0 should be used within disengagement research during the design, implementation, testing, and deployment of an intervention. The DisENGAGE Framework 2.0 encourages a holistic approach to disengagement research which will lead to a better, more representative understanding of current and future intervention use.

Chapter 12

Discussion

This thesis has investigated three case studies using the DisENGAGE Framework. This chapter will explore some of the themes that have emerged from this analysis, including the impact of notifications on (dis)engagement, the importance of an individual's motivation in digital and behavioural disengagement, and some of the challenges of interdisciplinary research.

12.1 The Differences Between the Case Studies

This thesis has presented three different case studies which analysed three very different DBCIs. Each case study explored an intervention that had a different 'intended usage' because they focused on different 'desired behaviours or treatments' and therefore had different 'target audiences' in mind.

PRIMIT (case study 1) contained four sessions, which participants were expected to complete weekly. CIRCA (case study 2) explored a DBCI that aimed to support an individual's self-management of cochlear implants and therefore the intended usage was 'use when needed'. Finally, Getting Active (case study 3) provided asthmatics with a DBCI to help them increase their physical activity. Participants were told to use this as much or as little as they wanted but the DBCI encouraged users to set goals, which were meant to be reviewed and reset each week. However, this does not account for the other content that can be viewed whenever a user desires. These different intended usage patterns present a challenge to researchers because it is difficult to know what *good* adherence would look like.

Understanding that engagement is more than usage is importance. However, usage is still a required form of measurement to understand the behavioural aspect of engagement. Therefore engagement researchers would typically look for patterns of usage that *adhere* to the *intended usage* (see Chapter 3 for definitions of these terms). PRIMIT has the

most predictable usage pattern, with one session every week for four weeks. However, there is no way to predict CIRCA usage because researchers will not know when the individual required assistance with their cochlear implant. It could be argued that Getting Active should have a minimum of one login per week, to update goals. However, this does not account for the additional content such as getting active ideas or support that the intervention offers. It is also important to remember that an individual might have kept the same goal each week and therefore non-usage (digital disengagement) does not translate into behavioural disengagement. Focusing on disengagement (and critiquing usage data) helps to better understand these individuals and their DBCI experience.

Many DBCIs are not for everyday use, but rather a tool to be used on a more occasional basis, to support the individual when they are attempting to change their behaviour or manage their illness. This means that each user is likely to have a different level of engagement with the DBCI, depending on the wide-ranging factors indicated in the DisENGAGE Framework. This is one of the challenges faced by engagement researchers. However, exploring non-usage and a better appreciaton of the factors that lead to disengagement can pro-actively help researchers to understand their 'target audience'.

These studies focused on different types of 'desired behaviours' or 'treatments', and therefore catered for different 'target audiences'. This variety in target behaviour – hand washing, self-management, and physical activity – will affect the likelihood of usage and disengagement. An individual is more likely to have 'motivation' and 'usage intention' when the DBCI is 'tailored' to them and their specific health condition (Wangberg & Psychol, 2013, p.340). It is therefore likely that these different populations would have different basic levels of engagement. However, these different contexts – especially the 'use when needed' scenario – means that without additional data it is impossible to know whether the individual is using the DBCI as intended.

These case studies highlight the differences in DBCI research. However, they all utilised the DisENGAGE Framework to explore and investigate usage. Although PRIMIT (case study 1) did not find a difference between the various factors ('gender' and 'perception') and patterns of disengagement, it did highlight that the largest group of participants that disengaged were the participants who also did not provide any perception ratings. These participants disengaged for a reason and it is important to understand why these individuals did not return. This might have been due to an increase in their hand hygiene, but regardless of this they did not return to see if they could learn more from the later sessions. Using the DisENGAGE Framework within CIRCA (case study 2) identified a number of potential disengagement factors relating to the DBCI. Additional data would have contextualised and confirmed certain hypotheses but simply using the usage logs identified a number of issues with the DBCI that needed addressing. Getting Active (case study 3) utilised a mixed methods approach which led to a better understanding of the individuals, their needs, and their reasons for disengaging.

12.2 Notifications

There were a number of interesting impacts of 'notifications' on both online and offline behaviour (see Figure 12.1). This section discusses these various impacts and further explores how these notifications should be presented.

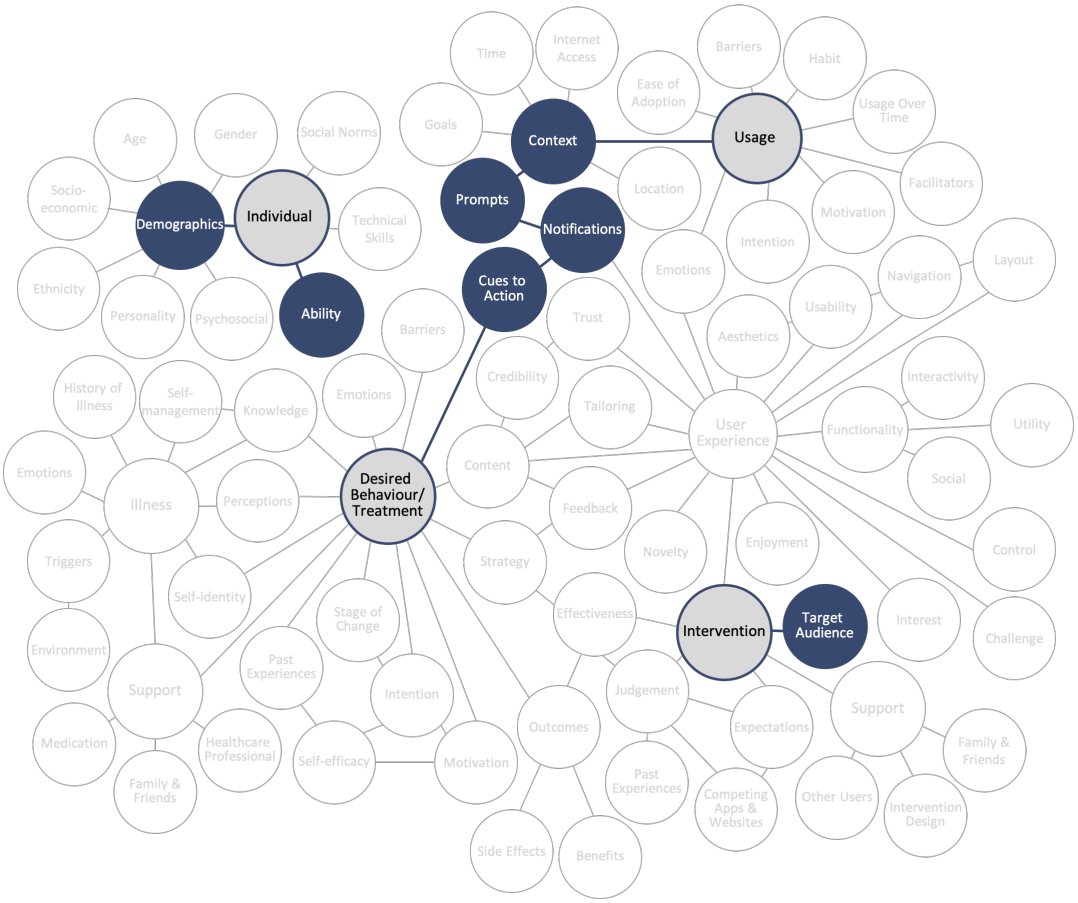

Figure 12.1: The DisENGAGE Framework 2.0 factors that relate to notifications within the case studies

12.2.1 Notifications Acting as a Prompt

'Notifications' seemed to 'prompt' the 'usage' of the DBCI in both case study 2 (CIRCA) and case study 3 (Getting Active). This finding is supported by a number of existing studies which find a positive correlation between 'notifications' and DBCI 'usage'. For example, Ryan *et al.* (2017, p.706) found that weekly usage of their Facebook app peaked on Wednesdays, the day the weekly email was sent out; and Bentley *et al.* (2013, p.18) found that notifications reminded users to enter data into their 'Health Mashups' system.

Interestingly, 'notifications' not only led to 'usage' of (or re-engagement with) the DBCI but it also led to 'desired behaviours'. The mixed methods approach carried out in

Getting Active enabled further exploration of the role of notifications. A number of participants reported that 'notifications' had prompted their physical activity, highlighting a causal relationship between the notifications and 'desired behaviour'. A link between notifications and the fact that they prompt activity has been identified in a number of other studies, including Klasnja *et al.* (2018, p.7) who found that tailored walking suggestions (in the form of push notifications) prompted the receiver to go for a walk. These 'notifications' act as a 'cue to action', explained by models such as the 'Health Belief Model' (HBM) (see Section 4.1.1).

This relationship between 'notification' and 'desired behaviour' has not just been found with activity promoting DBCIs. In a systematic review of 'periodic prompts' (i.e. notifications) it was found that they were effective in improving diet, weight loss, and physical activity (Fry & Neff, 2009). Freyne *et al.* (2017) found that 40.1% of their participants weighed themselves during the two hours following a prompt (a 'desired behaviour') and could therefore enter this data into the system. Although this study was not able to record the exact time that the users weighed themselves, this behaviour had to be done before they could complete this morning task.

However, this study also highlights the challenges faced by Behaviour Change researchers. 'Desired behaviours' are often not tracked within the DBCI itself. In this case it is assumed that the 'notification' was the 'cue' that led individuals to weigh themselves but this was not confirmed by the data. For example, Getting Active participants (case study 3) were asked to review their weekly goals but there was nothing that tracked the time or location of these completed goals. Without the additional qualitative data, the relationship between the 'notifications' and their activity would not have been identified. Understanding what happens offline and the role that the DBCI (and its components) plays in this context is imperative to developing better interventions.

The relationship between 'notifications' and 'prompting' behaviour is one of the motivators for the 'just-in-time adaptive intervention' (JITAI). This type of intervention aims to 'provide the right type/amount of support, at the right time' utilising new technological developments (Nahum-Shani *et al.*, 2018). A number of the Getting Active participants requested more 'tailored notifications' to 'prompt' certain activities at certain times. This tailoring was not possible using the LifeGuide software but a different platform or DBCI could provide this 'cue to action' to further facilitate the individual's behaviour change attempt.

12.2.2 Types of Notifications

Getting Active only offered notifications via email, which was one the of the criticisms raised by a number of the participants. Participants requested a number of different formats for future iterations of the DBCI, including push notifications and social media

prompts. However, previous studies have found inconsistency in the effectiveness of different notification formats.

Alkhaldi *et al.* (2017) found that just under half of the emails sent showed a significant association with DBCI usage; whereas they found no significant association between text messages and usage. Muench & Baumel's (2017) research contradicted this finding, suggesting that text messages have the highest 'immediate view and response rates', in comparison to other types of notification. Several Getting Active participants asked for push notifications but Simons *et al.* (2018) – in a study aimed to promote physical activity using the 'Active Coach' DBCI – found that this form of 'prompt' was often missed or lost amongst other notifications.

In contrast, Muench & Baumel (2017) found that any type of 'notification' – email, text message, social media banner, push alert etc – 'prompted' users to engage (or re-engage) with the intervention, but that the most appropriate medium depended on a number of factors, including 'demographics' and personal 'ability'. It is therefore important to select the most appropriate form of notification tailored to the 'desired behaviour' (or 'treatment') and the 'target audience'. Therefore, although certain Getting Active participants requested particular formats, these would need to be explored further to find the most effective medium in each case.

12.2.3 Summary: Notifications

'Notifications' appeared to 'prompt' DBCI usage in both the CIRCA and Getting Active case studies. In addition, a causal relationship was found between the Getting Active emails and the performance of 'desired behaviours'. These 'cues to action' are often overlooked in studies because this data is not recorded in the intervention. Understanding the role of 'notifications' in supporting users can help to provide more 'tailored' and time appropriate 'cues' to further aid their behaviour change attempts. Several Getting Active participants asked for alternative forms of notifications (other than email). However, studies suggest that the most effective format depends on the users and therefore DBCI studies should test 'notification' formats with their 'target audience' in order to identify which might be most effective.

12.3 Motivation

'Motivation' is a complex phenomenon, especially within DBCI research, because it relates to a range of disengagement factors (see Figure 12.2), including the usage of the intervention, the behaviour change attempt itself, and participation in the research study. Understanding this motivation at an individual level is crucial if one is going to understand reasons for disengagement.

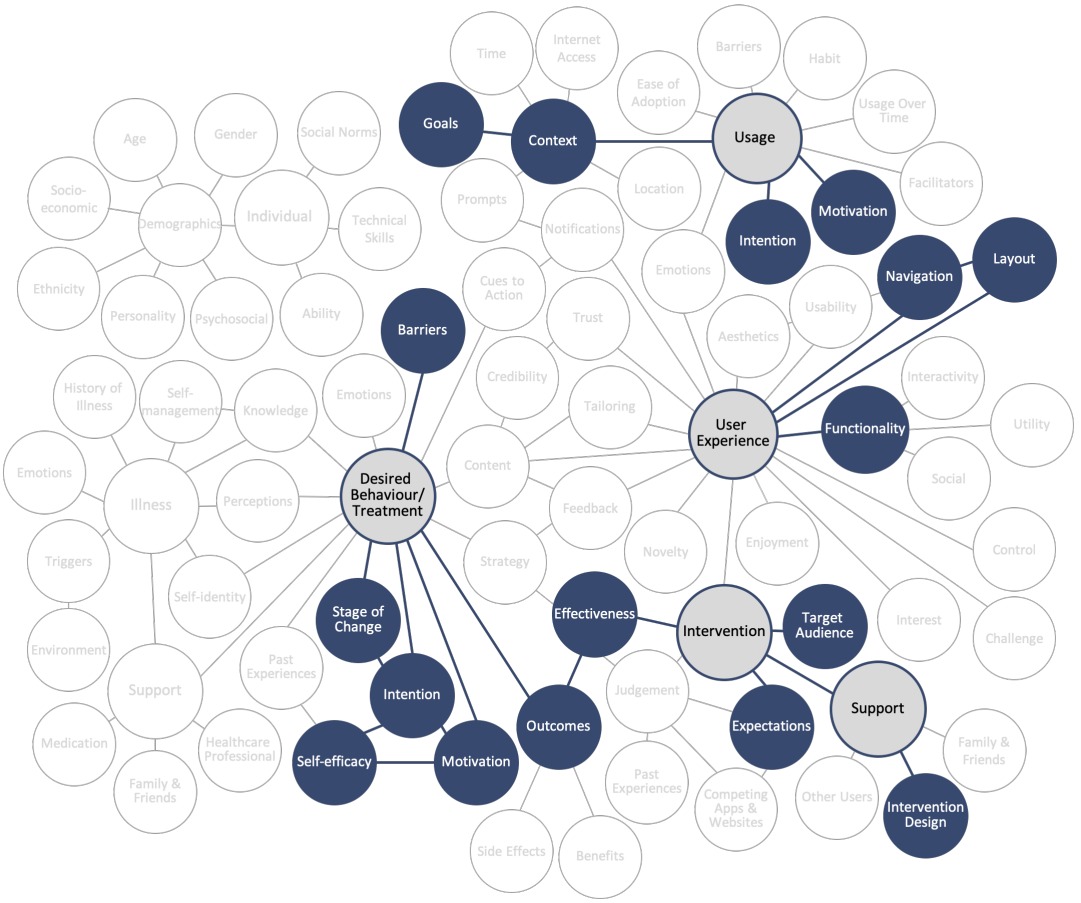

Figure 12.2: The DisENGAGE Framework 2.0 factors that relate to motivation within the case studies

Participants in all three case studies overlooked some areas of the DBCI. For example, there were numerous non-usage dropouts between each session in the PRIMIT study (case study 1). In addition, several participants did not view the main content of the CIRCA intervention (case study 2) and many of the Getting Active participants (case study 3) missed entire sections of the DBCI. Without additional data one can only hypothesise about the reasons for this digital disengagement. However, further exploration of the usage logs provided some potential reasons for the CIRCA participants' disengagement.

A number of CIRCA participants (case study 2) failed to complete the mandatory pages, which prevented them from viewing the main content. It is not clear whether they were aware of the additional material and just lacked the 'motivation' to complete the questionnaire, whether they were unaware due to the DBCI's 'navigation' and 'layout', or whether they were motivated by different 'usage goals'. For example, they may have simply been motivated to use the hearing test 'functionality' and that this alone fulfilled their 'usage goals'. Understanding 'usage goals' and 'motivation' can help researchers understand whether the DBCI is fit-for-purpose.

During the retrospective interviews, several Getting Active participants (case study 3) explained that they still had an 'intention' to be more active but had no 'intention' of using the DBCI to achieve this. The DBCI was therefore not fit-for-purpose, as 'functionality' failed to meet their 'expectations' and requirements. This feedback is a damning assessment of the DBCI showing that it has failed to support these individuals in their behaviour change attempt. However, understanding that these users were still motivated to carry out the 'desired behaviour' has highlighted that disengagement for these individuals was due to the intervention itself and not a lack of 'motivation' for their behaviour change attempt.

An individual may also lose 'motivation' to change their behaviour. There are multiple reasons for this which may be beyond the DBCI's scope. For example, the user may not be in the correct 'stage of change' (Prochaska & Velicer, 1997, p.39), and therefore in this case is not the intended 'target audience'. However, there may be 'barriers' that the individual needs support in overcoming and this is what the DBCI is meant to do. It is therefore important to understand the lack of 'motivation' and ensure that an individual is not failing simply due to a lack of 'support' as a result of the DBCI's design.

The disengagement analysis from case study 3 also identified that some participants were 'motivated' to be part of the study but were not motivated to change their behaviour. Several of these participants set themselves easy goals that they knew they could easily achieve. Others explained that they used the DBCI because they knew they were going to be interviewed about the intervention. This type of 'motivation' results in misleading usage data. There is no way of knowing from the usage logs alone that these participants were 'motivated' by the study rather than by a behaviour change attempt. These participants are reacting to the research by behaving in a way that they think is desired by the researcher. This is known as the 'Hawthorne effect' (Bowling, 2014, p.376). This results in misleading usage quotes and inaccurate conclusions about the usefulness and effectiveness of the intervention.

Furthermore, if this study had calculated engagement based solely on the usage logs then results would have misrepresented the DBCI's effectiveness, especially if the study had used *completed goals* as an outcome measure. This final form of motivation emphasises the importance of asking the right question and contextualising and understanding the collected usage data.

The Getting Active case study also identified an additional relationship between 'motivation', 'usage', and 'desired behaviour'. Some participants explained that they had no 'motivation' to return to the DBCI in the weeks where they had failed to complete their weekly goal, highlighting the importance of the 'outcome' of their behaviour change attempt and the 'effectiveness' of the DBCI in facilitating this process. This could have resulted from a lack of 'motivation' to carry out their 'desired behaviour' or from a

different kind of 'barrier'. Importantly, non-usage of the DBCI at this stage has further implications for the individual but also the design of the intervention.

When individuals fail to change their behaviour, they often require additional guidance and feedback (Michie *et al.*, 2014a, p.151) because their 'motivation' and 'self-efficacy' can often be affected (Hardy III, 2014, p.157). This is therefore a significant moment in any individual's behaviour change attempt; they may need to re-engage with the DBCI to address these issues and get their behaviour change attempt back on track. The relationships between these factors can provide further explanation for disengagement and the barriers that need to be overcome.

Individual motivation is crucial for understanding the reasons for disengagement. A lack of 'motivation' to use the DBCI itself is not always a bad thing. The individual may have been successful in the behaviour change attempt or may be utilising the strategies that they have already learnt from the intervention. However, a lack of 'motivation' to carry out the 'desired behaviour' can lead to unsuccessful behaviour change attempts, which can result in a lack of 'motivation' to use the DBCI, causing a vicious cycle of failure. These individuals will not successfully change their behaviour. Finally, understanding that an individual is actually 'motivated' by the research study and not the behaviour change attempt can help to identify misrepresentative usage logs and potentially misleading participant feedback.

12.4 Collisions of HCI and Psychology

There are some fundamental differences between the disciplines of HCI and Psychology (or more specifically Behaviour Change). One of these is the different methodological approach taken by each group of researchers. Some of these differences have been outlined in an interesting article by Blandford *et al.* (2018), which explains the various challenges of interdisciplinary DBCI work. One of the fundamental issues relates to who is considered the 'expert'.

By researching theory and identifying appropriate mechanisms of action, Behaviour Change researchers consider themselves to be the experts as they start to develop the DBCI. In contrast, HCI researchers consider the *user* to be the expert and the central focus of the design. This belief has led to the highly used 'User-Centred Design' (UCD) approach, which focuses on a good user experience and usability (Nebe & Baloni, 2016, p.442). This approach starts with the user and develops a set of requirements based on their needs and context of use (Deuff & Cosquer, 2013, p.14).

Working across disciplines presents a number of different issues including the issue of creating a good UX, potential conflicts within the design, and the limitations of the

LifeGuide tool. These present a range of issues that can lead to an increase in DBCI disengagement (see Figure 12.3).

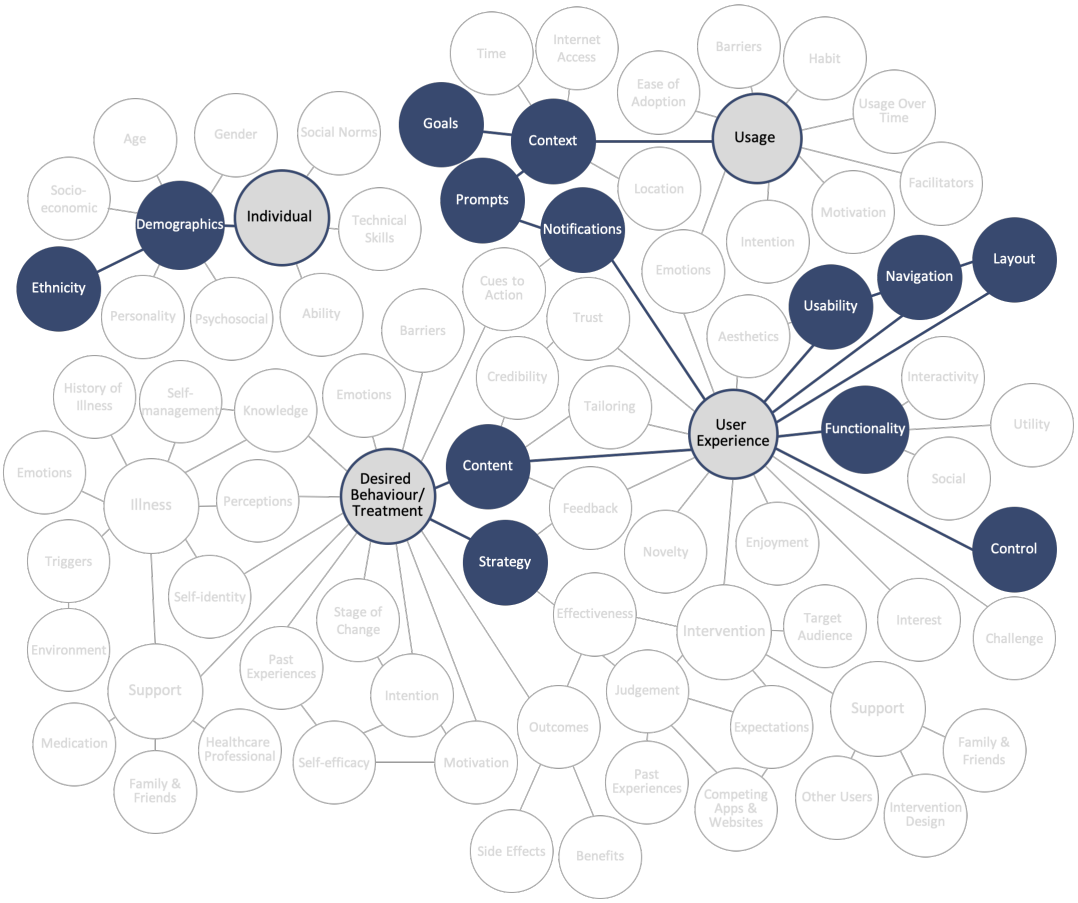

Figure 12.3: The DisENGAGE Framework 2.0 factors that relate to the challenges of working across disciplines

12.4.1 Creating a Good User Experience

The importance of good usability is well-known and researched within HCI and poor usability has been identified as a reason for the lack of adoption and usage of DBCI (Brown III *et al.*, 2013, p.1081). This issue is therefore not new and yet there are many DBCIs that are still not tested with the 'target audience' before the main data collection stage of the research. For example, CIRCA (case study 2) did not carry out any usability testing with their intended users. This is partly due to the consideration of who the expert is, but also to the intended research outcomes.

HCI research primarily focuses on the user wanting to understand their experience and interaction with the technology, putting them at the centre of the process. Behaviour Change research wants to bring about behaviour change, which uses the technology to facilitate a 'desired behaviour', but ultimately focuses on the real-world impact rather

than the technology (i.e. the effectiveness of the intervention in facilitating this process). Traditionally this explains why usability was often overlooked. For example, 'usability' is not mentioned in the original 'Development-Evaluation-Implementation Process' developed by the Medical Research Council (MRC) (see Section 2.2.1).

Behaviour Change researchers are starting to consider the usability of DBCI but this is often still limited to the early stages of development such as in the PBA. There are many problems with the failure to adopt a more User-Centred Design (UCD) approach, including the limitations of studies that only use think-aloud approaches.

Think-aloud research from the DBCI development stage can generate misleading data. Hertzum & Kristoffersen (2018) explain that prompts given by a moderator can change the user's behaviour leading to an unrepresentative account of how the individual would have used the system in the real-world. Participants are often encouraged to view all the pages – exploring all the DBCI – so that the researcher can identify as many issues as possible. This type of data collection was seen during the Getting Active think-aloud (case study 3). For example, one of the participants thought they had explored the entire system and it was only due to subtle prompts by the moderator that they found the remaining pages. This may have led users to click on links which they would not otherwise have followed, in this case missing the fact that the participants did not understand the labelling of the sections. In addition, during subsequent questioning, this individual said that the DBCI was easy to navigate. Bolle *et al.* (2016) found a similar issue with their participants; 70% (n=16) of users stated that it was easy to find information and yet researchers observed major navigational problems for 91% (n=21) of users, preventing them from finding the requested information. It is therefore important to consider all observable data during this type of usability study.

In addition, it is possible that simply taking part in the think-aloud changes the individual's behaviour, due to the very process of thinking aloud (Gill & Nonnecke, 2012). This change in behaviour is often referred to as 'reactivity', and can result in unidentified usability issues or the identification of false positives (Alhadreti & Mayhew, 2017, p.112). It is therefore important to recognise the value of collecting data at different stages and in different formats. The usage logs from CIRCA (case study 2) and Getting Active (case study 3) led to the identification of a number of usability issues, including unclear navigation, confusing labelling, and misleading layout. However, the lack of contextual data in the CIRCA study (case study 2) limited this analysis. Furthermore, there are some emergent problems that only arise during the use of a DBCI in its intended environment (Hertzum, 2016, p.86).

The mixed methods approach taken with Getting Active (case study 3) helped identify that misleading labels led participants to ignore certain sections and that the layout of a page made users miss hyperlinked content. The usage logs alone could only show that these pages had not been visited, but could not explain why. Crane *et al.* (2017)

also identified different usability issues during the initial think-aloud study compared to their semi-structured interviews after a two week usage period.

There are many Behaviour Change researchers and approaches that have started to incorporate think-alouds and other usability testing in the early stages of development, such as the Person-Based Approach (PBA) (Yardley *et al.*, 2015). However, this discussion has highlighted the importance of including a UCD approach. These approaches are not mutually exclusive and as Yardley *et al.* (2015) suggests can (and should) be used together. However, there are still a lot of DBCIs being produced by Behaviour Change researchers without the benefits of well-known HCI methods, such as usability testing.

12.4.2 Navigational Design

The differences between approaches are possibly most significant when the discipline recommended techniques or designs appear incompatible, such as the issue of the DBCI's navigation or architecture. This caused problems for a number of participants in each of the case studies.

Like many DBCIs, these three interventions used 'tunnelling' to guide users through the pages. This technique allows researchers to set the order of the viewed pages, often to provide a step-by-step process (Danaher *et al.*, 2015). It has been adopted from persuasive systems design research, specifically the 'Persuasive Systems Design Model' (Oinas-Kukkonen, 2013, p.1228) (see Section 4.2.3). It allows researchers to control when users see certain content and can therefore mimic a real-world session-based behavioural intervention. This is a highly utilised technique within DBCI design and has been found to lead to more page views and an increase in knowledge gained from the intervention (Crutzen *et al.*, 2012). However, this was not always the case for the participants of the three case studies. The PRIMIT architecture (case study 1) restricted content by releasing weekly sessions. Individuals who dropped out prematurely (before the fourth session) did not have the option to view all the content. CIRCA participants (case study 2) were unable to view the main intervention content until they had completed all the questionnaire pages. Unfortunately, several participants never reached this point. Significantly, this architectural design directly conflicts with the best practices adopted by HCI research.

Garett *et al.* (2016) conducted a literature review in the *Online Journal of Communication and Media Technologies* to identify and define the design elements of an engaging website. This research suggests that 'effective navigation' consists of multiple routes through a website, to support easy access to pages and limits the number of clicks or the need to backtrack (Garett *et al.*, 2016, p.4). A tunnelled architecture prevents this form

of navigation by offering one route through the system and controlling the individual's navigation.

Furthermore, a number of Getting Active participants (case study 3) complained about the lack of navigational flexibility, explaining that they liked to scan pages quickly to find the content they wanted. They also stated that the inability to freely navigate the DBCI would lead them to disengage from it. This 'scanning' method (of information processing) is explained by Kinley *et al.* (2014) in their research. They investigated the effect of cognitive styles[1] on how individuals search the Web, including their navigational style and their approach to information-processing. As part of this research, they constructed a model to explain that an individual's cognitive style dictates whether they 'scan' or 'read' during information processing. 'Scanners' are more likely to 'search quickly', switching 'between topics, tabs, and windows', and open 'more result pages' (Kinley *et al.*, 2014, p.1115). This presents a conflict between the tunnelled architecture and the way in which these individuals would naturally find information and navigate around the Web, or in this case navigate within the DBCI. There are additional studies which suggest that navigational style can be dependent on other factors, such as culture ('ethnicity') (Cyr, 2014) and 'usage goals' (van Oostendorp & Aggarwal, 2015).

As stated above, these disciplines (and their approaches) are not mutually exclusive. They can learn a lot from one another but the case studies presented in this thesis highlight some of the issues with the tunnel approach. Some Behaviour Change researchers acknowledge that there needs to be some flexibility in the tunnelled architecture to offer choice and enhance an individual's sense of autonomy (Morrison, 2015, p.3), thereby increasing the user's sense of 'control'. For example, Michie *et al.* (2012, p.265) employed a hybrid architecture to offer a menu bar and choice whilst ensuring that key content was seen using the tunnel approach.

These differences further highlight the need for interdisciplinary work, to ensure the best possible DBCI design. The DisENGAGE Framework can guide researchers by highlighting the disengagement factors across a range of disciplines. For example, some disengagement factors are caused by design choices taken by a specific discipline. A particular strength of the DisENGAGE Framework is that it can identify and address these issues as they arise. Furthermore, the DisENGAGE Framework helps to ensure that researchers consider both behavioural and digital factors, not limiting the focus to their specific discipline.

12.4.3 Limits of LifeGuide

This research has focused on three case studies which all utilised the LifeGuide software. LifeGuide was developed to help Behaviour Change researchers develop DBCI

[1] Defined as 'an individual's preferred and habitual approach to organize and represent information' (Riding & Rayner, 1998, cited in Kinley *et al.*, 2014, p.1107)

without requiring advanced programming skills. The software supports a tunnelled architecture and the tracking of usage data, which is widely used by Behaviour Change researchers. However, LifeGuide has its limitations which will have affected the disengagement analysis. As discussed in Section 12.4.2, some participants navigate the Web by quickly opening different tabs and windows. This type of usage is not supported within LifeGuide. Although DBCI will support multiple tabs, this usage is not accurately tracked within the usage logs. There are also other features that LifeGuide cannot support, such as tracking which 'notifications' led to DBCI usage. Embedded links within an email can drive the user straight to the DBCI and this data can often be stored within the usage log to identify which 'notifications' 'prompted' participants to 'usage'. This 'functionality' is not supported within LifeGuide and therefore any discussions about 'notifications' and 'usage', such as in the CIRCA analysis (case study 2), can only be hypothetical.

LifeGuide also does not support the development of mobile-based apps. The software helps researchers generate websites but this has not been extended to mobile formats. This further limits the accessibility of the DBCI and potentially creates an additional barrier for users. Although this system has its limitations, the Behaviour Change researchers nonetheless selected it as their tool for developing the DBCIs because it still offers a flexible format for creating an intervention without programming knowledge.

12.4.4 Summary: Collisions of HCI and Psychology

There are a number of challenges in interdisciplinary DBCI research. Typically Behaviour Change and HCI researchers prioritise different elements of the DBCI, which is often reflected in the time and resources allocated to the various aspects of research. For example, Behaviour Change researchers prioritise the identification and use of theory to ensure that the DBCI utilises the most effective Behaviour Change Techniques (BCTs) but sometimes overlook the 'user experience' or 'usability' of the DBCI. Researchers are increasingly checking the 'usability' of DBCIs during development but often without utilising a UCD approach (throughout the entire process), which means that emerging 'usability' issues will not be identified and could become barriers to use, leading to disengagement.

It is also important to consider where design strategies conflict, such as the DBCI's navigational design. Behaviour Change researchers use tunnelling to guide users through a set series of content; but this conflicts with HCI's recommendations that effective 'navigation' should offer multiple routes throughout a system. It is important to try and find a middle ground to ensure a good 'user experience' whilst keeping the prominence of the key theory-based content. A combined approach of UCD and a theory-based approach (such as the PBA) can help to address these issues.

Finally this section has identified some of the limitations of the LifeGuide software. These include its inability to support the opening of multiple tabs, to track which 'notifications' led to usage, and the inflexibility in DBCI format (web-based rather than app-based).

12.5 Summary

This chapter has explored some of the key themes identified across the three disengagement case studies, including the differences between DBCIs, the role of 'notifications', the impact of an individual's 'motivation', and collisions between the Behaviour Change and HCI research.

This discussion has further highlighted the link between digital and behavioural disengagement factors. For example, the failure to meet a behaviour change goal (behavioural) leading to a lack of motivation to use the DBCI (digital). There was also a positive relationship between the 'notifications' (digital) providing a 'cue to action' and leading to the 'desired behaviour' (behavioural). These relationships are often not recorded in traditional usage data and therefore vital aspects of an individual's DBCI experience are overlooked.

Disengagement research encourages researchers to carry out in-depth analysis of data, ensuring that it is contextualised with user-specific data. Understanding an individual's personal usage context can help to identify issues across groups of users. For example, understanding that several individuals process information by 'scanning' helps to explain why the tunnelled architecture became a barrier to their usage.

Disengagement research will help to create more usable, useful DBCIs. This chapter has shown that the DisENGAGE Framework 2.0 can provide insights across a range of DBCIs, within a variety of contexts, leading to a better understanding of the 'target audience', their 'usage', and reasons for their disengagement.

Chapter 13

Conclusions and Future Work

Digital Behaviour Change Interventions (DBCIs) are growing in popularity as they are able to reach a wide audience, reduce the pressure on healthcare professionals, and can offer 24-7 guidance and support. However, for them to be effective a user has to engage with the content and strategies they provide both on and off-line.

Engagement is a multifaceted phenomenon, which is difficult to define, identify, and measure. Previous research *suggests* that engagement is a subjective experience with emotional, cognitive, and behavioural components. It is also temporal by nature, which occurs at varying levels within and across sessions. In addition, HCI literature states that an interaction with technology is a personal experience, affected by a user's past experience, personal standards, as well as by their emotional state. This conceptualisation of engagement presents a series of challenges for researchers, especially those trying to operationalise engagement. This often leads to engagement being reduced to one single metric: usage.

Researchers represent engagement as 'usage' because it is easy to measure, does not require specialist equipment, and at the very least portrays part of the phenomenon. However, this reporting is misleading as usage is not an accurate representation of engagement; only illustrating the behavioural component. These researchers are interested in engagement to better understand and improve the effectiveness of the DBCI. However, there is another approach. This thesis has presented a new tool – the DisENGAGE Framework – which can be used by any researcher, with any DBCI to better understand the target audience, their intervention usage, and their behaviour change attempts.

13.1 Summary

The following thesis statement provided the focus for this piece of research.

> Adopting a new formal framework of disengagement factors will enable a better understanding of why users disengage from DBCIs, and therefore contribute to improved and more holistic designs in the future.

This thesis proposes a new DisENGAGE Framework, and shows how it provides novel insights into how individuals use a range of DBCIs. In addition, it puts forward a process for analysing the data which will provide more relevant and accurate guidance for future intervention designs. The following four research aims have guided and directed this research into disengagement.

RA1 Develop an overarching vocabulary to describe aspects of disengagement with behavioural intervention research.

RA2 Review and critique the latest Behaviour Change and HCI research to create a theoretical framework for disengagement from DBCIs.

RA3 Investigate how qualitative and quantitative (usage) data can be used to understand disengagement using the framework.

RA4 Demonstrate how the theoretical framework can guide researchers through the process of disengagement research, including planning for, collection of, and analysing disengagement data.

The following sections demonstrate how these four research aims were addressed in this thesis.

13.1.1 A Taxonomy of Disengagement (RA1)

> RA1 Develop an overarching vocabulary to describe aspects of disengagement with behavioural intervention research.

There are multiple terms within the Behaviour Change literature that relate to an aspect of DBCI research, including adherence, attrition, and dropout. These terms are all similar but are used distinctively within the research. Along with their related research, they can therefore provide different and distinctive perspectives on the process of disengagement. The 'Taxonomy of Disengagement' presented in Chapter 3 explains how these different terms – along with their associated research – can provide data for the three newly-defined types of disengagement. These are as follows:

Digital Disengagement: when a participant decides to stop using the intervention technology, or when factors in the participant's external environment cause them

to cease using the technology.
Indication: Digital adherence, Non-usage attrition, User Engagement, User Experience

Behavioural Disengagement: when a participant decides to stop using the intervention content material, or when factors in the participant's external environment cause them to cease following its guidance.
Indication: Behavioural adherence

Digital-Behavioural Disengagement: when a participant decides to stop using the intervention technology and content material, or when factors in the participant's external environment cause them to cease.
Indication: All of the above

In addition, exploring DBCIs requires an interdisciplinary approach that looks at the behavioural and digital influences on an individual's behaviour change attempt. This type of research is often hindered by studies that simply focus on one particular term, creating discrete and disconnected research areas within the wider research community. By using a more interdisciplinary approach the taxonomy proposed in this thesis can be used as a tool to facilitate conversations across disciplines and encourage the development of existing knowledge and models.

13.1.2 A Framework for Disengagement (RA2)

RA2 Review and critique the latest Behaviour Change and HCI research to create a theoretical framework for disengagement from DBCIs.

There are multiple models within Behaviour Change that look at behaviour or engagement with DBCIs. However, none of these models focus specifically on disengagement, nor upon the added value that this type of data can provide for DBCI development and research. This thesis contributes to this field of study by concentrating more specifically on disengagement.

Chapter 4 focused on Behaviour Change literature, following a maximum variation sampling technique in order to reduce the research silos identified above. The models presented in this chapter discussed various aspects of digital disengagement but did not focus on the real-time experience of individuals actually using a DBCI. This helped to highlight the need for a more truly interdisciplinary approach to the issue of disengagement, which incorporated insights from technology adoption, User Engagement (UE), as well as User Experience (UX).

Building on this, the HCI models critiqued in Chapter 5 provided the digital disengagement factors for DBCIs. None of these models were designed to focus on disengagement

as such and therefore I had to identify the important relevant factors and then reframe these for the context of behaviour change. This led to the development of the DisENGAGE Framework presented in Chapter 6 (which was updated in Chapter 11).

In the past, DBCI research very often separated the psychological and technological factors of (dis)engagement, which has the effect of reducing the range of conclusions that can be drawn. By combining insights from the fields of Psychology and Computer Science, the interdisciplinary nature of the framework proposed in this thesis ensures that researchers explore disengagement through a holistic lens, capturing both the digital *and* the behavioural aspects of the phenomenon. Non-usage of a DBCI may be due to behavioural barriers or it may be due to digital features of the intervention. This framework provides an interdisciplinary tool for researchers as well as developers, in order to improve the design and effectiveness of future DBCIs.

13.1.3 Using the DisENGAGE Framework to Understand Disengagement (RA3)

> RA3 Investigate how qualitative and quantitative (usage) data can be used to understand disengagement using the framework.

Each of the three case studies presented in this thesis explored a different aspect of disengagement. The following sections provide a short summary of these and how they further inform disengagement research.

13.1.3.1 Case Study 1: PRIMIT

Case study 1 explored disengagement from a large-scale intervention, known as PRIMIT (PRimary care trial of a website based Infection control intervention to Modify Influenza-like illness and respiratory tract infection Transmission). The PRIMIT intervention aimed to promote hand washing during a flu-epidemic.

This analysis focused on two areas of the DisENGAGE framework (gender and perceptions) to explore their effect on disengagement. Although the data did not provide evidence for any strong conclusions relating to these two factors, the chapter did provide new insights into the need for a disengagement research *process* and disengagement focused data collection.

For example, this case study shows that analysing usage logs retrospectively will often have an impact the quality of the conclusions. In this particular case, the perception-related questions were not compulsory and the group with the highest rate of dropout had the lowest completion rates for this section of the questionnaire. These individuals may have dropped out because they had already been successful with their behaviour

change attempt, or they may have disengaged for another reason, such as the intervention content or user experience.

This thesis therefore highlights the need to plan for disengagement data – specifically the point at which it is collected, as well as the method of collection. The perception questions were collected at 16 weeks, which may have been weeks after the individual digitally disengaged. Furthermore, the perception questions were not compulsory which produced a low response rate. It suggests that if researchers try and collect data too often participants may find it intrusive and irritating, which could lead to more participants disengaging. Equally, making questions compulsory could lead to participants failing to complete any of the questionnaire. It therefore makes the case that it is important for researchers to plan and consider their data requests, aided by the DisENGAGE Framework and the research process, set out in Chapter 11.

13.1.3.2 Case Study 2: CIRCA

This case study explored a small-scale intervention called 'Cochlear Implant Remote CAre' (CIRCA); aiming to support recipients of cochlear implants. The original study found an increase in levels of empowerment using the CI-EMP, that hearing levels had stabilised in the intervention group, and that patients were keen to continue using the DBCI. It had also reported a low rate of dropout – 2% – in the original study and this was explored in the disengagement analysis.

This thesis utilised the DisENGAGE Framework to highlight a number of interesting usage patterns. For example, it identified a number of barriers to usage, such as disinterest in the content, login issues, and notifications. Although many of these participants did not officially dropout, these usage barriers did appear to cause several to digitally disengage. Whilst it was impossible to confirm or disprove the various hypotheses relating to these digital disengagement factors, this thesis highlights the fact that the *official* dropout rate of 2% may not accurately represent the usage of the DBCI or the experience of the CIRCA users.

In addition, by using the case studies of PRIMIT and CIRCA, this thesis highlights the need for additional data relating to the DisENGAGE Framework factors. In particular, it shows that collecting qualitative data in addition to usage data leads to a more comprehensive understanding of intervention usage. However, it also shows that without this additional data, the CIRCA case study identified a number of actionable issues that could reduce the barriers to usage and thereby reduce digital disengagement.

13.1.3.3 Case Study 3: Getting Active

Case study 3 presented a different approach to analysis (following the process explained in Chapter 11) conducting the disengagement research alongside the original research objectives. The proposed DisENGAGE Framework guided the planning, collection, and analysis of the disengagement data (RA4). A mixed methods approach provided the qualitative and quantitative (usage) data required for in-depth analysis. This data was then investigated using the DisENGAGE Framework (RA3) to suggest new insights into DBCI disengagement.

Specifically, the Getting Active analysis focused on the DisENGAGE factors that might predict future digital disengagement. This approach to data examination produced a number of new insights, highlighting multiple ways in which the DBCI could be improved, and reducing the chance of participants digitally disengaging.

This case study also highlighted various factors that interact on and off-line which can affect an individual's usage experience of the DBCI. Approaching their interaction with the intervention from a more holistic perspective – using the proposed framework – provides a new and better understanding of their DBCI usage, and helps to explain why they might behaviourally or digitally disengage from this behaviour change attempt.

13.1.4 The Process of Disengagement Research Using the DisENGAGE Framework (RA4)

> RA4 Demonstrate how the theoretical framework can guide researchers through the process of disengagement research, including planning for, collection of, and analysing disengagement data.

This thesis demonstrates that case studies 1 and 2 highlighted the limitations of retrospective usage analysis, including the problems of incomplete data and the lack of contextual information. Furthermore, the analysis in case study 3 exposed the misleading potential of usage logs, when used without the relevant contextual data.

This thesis therefore concludes that the DisENGAGE Framework – updated after the three case studies – is an important and integrative tool, designed to support the intervention designer through the entire process of disengagement research. Researchers therefore need to plan disengagement research to ensure that every relevant disengagement factor is identified, measured, and analysed. In particular, the mixed methods nature of this type of research also encourages the iterative cycle of data collection and analysis. The findings of this type of research should also lead to recommendations for improvements to the DBCI. The recommendations can inform the guidelines for DBCIs specific to the type of intervention, such as the desired behavioural outcome or the particular illness it aims to help manage.

This process of analysis was utilised during the Getting Active case study to highlight the utility of the proposed DisENGAGE Framework. Furthermore, Section 11.3 shows how these stages of disengagement analysis can be incorporated into well development processes, such as the established 'Person-Based Approach' (PBA).

13.1.5 Contributions

This thesis therefore makes four main contributions to the field of DBCI research.

Firstly, this research highlights the various challenges faced by engagement research and the misleading practice of representing engagement as usage. Instead it recommends that researchers focus on disengagement. There is a push within Behaviour Change research to identify 'effective engagement'; engagement that leads to a positive behaviour change outcome. However, the multi-faceted nature of this phenomenon means that measuring this form of engagement is even more challenging. It would require specialist equipment and furthermore these measurements will reflect the individual's unique experience with the DBCI at a particular point in time. In contrast, the focus on disengagement proposed in this thesis helps to identify the behavioural and digital factors that can cause an individual to disengage. Furthermore, it provides real-world insights into a user's DBCI experience which can help researchers reduce the barriers that lead to non-usage and dropout.

Secondly, this thesis presents a multi-faceted 'Taxonomy of Disengagement', which shows how disengagement-related terms provide different perspectives on the behaviour change process. Furthermore, it provides a new common vocabulary intended to bridge research silos and lead to more effective research. Terms have often been used interchangeably, but in practice they have unique traits which need to be understood and distinguished when exploring disengagement related work. This taxonomy offers clarity about such usage.

Thirdly, this work introduces the DisENGAGE Framework. It is a tool to help researchers across disciplines understand their target audience, find out more about how individuals use their DBCI, and identify the barriers that lead to disengagement (both behavioural and digital). The utility of this framework was tested using three case studies and this disengagement analysis helped identify several usage patterns, including issues with the DBCI designs, and significant relationships between various DisENGAGE factors. This tool encourages and enables Behaviour Change and HCI researchers to think more rigorously about the design, data capture, and examination of disengagement from their health-related DBCIs.

Finally, this thesis proposes and describes a research process that utilises the DisENGAGE Framework in an integrative way, including how the framework can be incorporated into a DBCI development process. This approach ensures that the phenomenon of

disengagement is explored holistically, leading to insights into DBCI design and usage, as well as how these impact an individual's experience of behaviour change.

13.2 Future Work

A focus on disengagement is a new approach that offers researchers a chance to understand their target audience and the use of the DBCI in their natural settings. Furthermore, the DisENGAGE Framework offers a tool that can be used within any research study, without specialist training or equipment, providing useful insights into barriers to usage and the relationships between disengagement factors. Understanding and identifying these barriers to usage can help to create more effective, useful and enjoyable DBCIs. In addition, these insights can further guide the future development of DBCIs.

One of the research barriers for progressing DBCIs is the inability to compare engagement values across studies; in part due to the unclear and inconsistent nature of reporting engagement. However, the DisENGAGE Framework can help to identify disengagement factors that are unique to a specific behaviour (or illness) and the intended target audience. Applying this framework to different types of interventions (including different behaviours or illnesses) will lead to a better understanding of DBCI usage within these specific contexts. Furthermore, this framework can be refined and expanded to create tailored versions for these different DBCIs.

One current research avenue, within HCI, relates to 'usage modes'. Hassenzahl (2005, p.40) proposes two usage modes: 'goal' and 'action'. A user in 'goal' mode is using the product as a means to an end, whereas in 'action' mode the use of the product is a means in itself. Individuals describe themselves differently in these two modes, either "'serious" and "planning"' or "'playful" and "spontaneous"' (Hassenzahl, 2018, p.20). The usage mode of the individual will affect how they evaluate and judge a product (Hassenzahl, 2018, p.21). Sutcliffe (2016, p.106) discusses these differences in relation to the 'application domain' and whether it is a 'game' or 'work' application. It is currently unclear which representation is more accurate. However, both researchers state that these differences affect the user's expectations, judgements and experience with the technology. This is an interesting area of exploration within Behaviour Change research because it is currently unclear how individuals perceive DBCIs, or what type of 'usage mode' or 'application domain' these fall within. Increasingly researchers are using 'gamification'[1] to encourage usage (such as Ryan *et al.* (2017) as part of their activity promoting DBCI). It is therefore important to understand how this type of feature impacts the user's perception of their DBCI, specifically the 'usage mode' or considerations of 'application domain'. The DisENGAGE Framework will help to identify a user's

[1] Most commonly defined as 'the use of game design elements in non-game context' (Sardi *et al.*, 2017, p.32)

expectations, judgements, and varying requirements to clarify their feelings about this. This will provide more guidance to DBCI designers and researchers.

Case study 3 started to identify various behavioural and digital factors that related to each other. For example, the connection between 'competing apps & websites', 'expectations', 'judgements', 'ease of adoption', and 'functionality'. In addition, there was a relationship between failed behaviour change attempts (failure to achieve their activity goals) and the non-usage of the DBCI. Furthermore, participants explained that the 'notifications' prompted them to perform their 'desired behaviour'. Using the DisENGAGE Framework to explore these relationships will help to progress disengagement research, identifying data points that should be collected together and informing Behaviour Change researchers of the interlinked aspects of the user, their behaviour change attempt, and their DBCI.

One of Oinas-Kukkonen & Harjumaa's (2009, p.492) persuasive strategies is personalisation. 'Personalisation' in this context refers to a system that 'offers personalised content or services' (Oinas-Kukkonen & Harjumaa, 2009, p.492). A personalised system can be adapted to suit an individuals' abilities and requirements (Orji *et al.*, 2017, p.413) and offers many benefits for Behaviour Change researchers. In addition, this type of system can be tailored to individual preferences; for example, a DBCI could follow a tunnelled architecture but provide flexibility for individuals that prefer to rapidly 'scan' pages to find their content (such as the participants in case study 3). Disengagement research provides an approach to identify disengagement factors which have the potential to be personalised for different users or context. Furthermore, the disengagement focus encourages the identification of the differences between users, understanding their barriers and more importantly the specific context in which these barriers occur. Personalisation research will benefit from the discoveries of disengagement research.

Finally, it is important to continue to research engagement alongside disengagement. Although the precise relationship between engagement and disengagement is still debatable, a better understanding of this phenomenon (using the correct measurements and equipment) can further help researchers understand the complex interaction between a user and DBCIs. Both areas of research will inform each other, and should continue to be studied for the mutual benefits that this will bring.

13.3 Conclusion

Engagement is a complex phenomenon and removing factors that lead to disengagement will not create an 'engaging' intervention for all users, at all times. Increasingly, Human-Computer Interaction (HCI) research suggests that an experience with technology is contextually-dependent. It can be affected by a user's past experience, by their current emotions, or by the location of usage. This suggests that a 'one-size-fits-all' approach

to creating an *engaging* intervention is unproductive. However, there are a number of common factors that repeatedly seem to cause a bad user experience, and are likely to lead to digital disengagement. The proposed DisENGAGE Framework helps to identify these factors, along with additional behaviour factors, in order to produce the best DBCI designs. Hopefully this will lead to more effective usage, better engagement, and therefore more successful behaviour change attempts.

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Appendix A

Behaviour Change Literature

Table A.1: 'Primary Task Support Principles' taken from Oinas-Kukkonen & Harjumaa (2009, p.492)

Principle	**Definition**
Reduction	A system that reduces complex behaviour into simple tasks helps users perform the target behavior, and it may increase the benefit/cost ratio of a behavior.
Tunnelling	Using the system to guide users through a process or experience provides opportunities to persuade along the way.
Tailoring	Information provided by the system will be more persuasive if it is tailored to the potential needs, interests, personality, usage context, or other factors relevant to a user group.
Personalisation	A system that offers personalised content or services has a greater capability for persuasion.
Self-monitoring	A system that keeps track of one's own performance or status supports the user in achieving goals.
Simulation	Systems that provide simulations can persuade by enabling users to observe immediately the link between cause and effect.
Rehearsal	A system providing means with which to rehearse a behavior can enable people to change their attitudes or behavior in the real world.

Table A.2: 'Dialogue Support' taken from Oinas-Kukkonen & Harjumaa (2009, p.493)

Principle	**Definition**
Praise	By offering praise, a system can make users more open to persuasion.
Rewards	Systems that reward target behaviors may have great persuasive powers.
Reminders	If a system reminds users of their target behavior, the users will more likely achieve their goals.
Suggestion	Systems offering fitting suggestions will have greater persuasive powers.
Similarity	People are more readily persuaded through systems that remind them of themselves in meaningful way.
Liking	A system that is visually attractive for its users is likely to be more persuasive.
Social Role	If a system adopts a social role, users will more likely use it for persuasive purposes.

Table A.3: 'System Credibility Support' taken from Oinas-Kukkonen & Harjumaa (2009, p.494)

Principle	**Definition**
Trustworthiness	A system that is viewed as trustworthy will have increased powers of persuasion.
Expertise	A system that is viewed as incorporating expertise will have increased powers of persuasion.
Surface Credibility	People make initial assessments of the system credibility based on a firsthand inspection.
Real-world Feel	A system that highlights people or organization behind its content or services will have more credibility.
Authority	A system that leverages roles of authority will have enhanced powers of persuasion.
Third-party Endorsement	Third-party endorsements, especially from well-known and respected sources, boost perceptions on system credibility.
Verifiability	Credibility perceptions will be enhanced if a system makes it easy to verify the accuracy of site content via outside sources.

Table A.4: 'Social Support' taken from Oinas-Kukkonen & Harjumaa (2009, p.495)

Principle	**Definition**
Social Learning	A person will be more motivated to perform a target behavior if (s)he can use a system to observe others performing the behavior.
Social Comparison	System users will have a greater motivation to perform the target behavior if they can compare their performance with the performance of others.
Normative Influence	A system can leverage normative influence or peer pressure to increase the likelihood that a person will adopt a target behavior.
Social Facilitation	System users are more likely to perform target behavior if they discern via the system that others are performing the behavior along with them.
Cooperation	A system can motivate users to adopt a target attitude or behavior by leveraging human beings' natural drive to co-operate.
Competition	A system can motivate users to adopt a target attitude or behavior by leveraging human beings' natural drive to compete.
Recognition	By offering public recognition for an individual or group, a system can increase the likelihood that a person/group will adopt a target behaviour.

Table A.5: Summary table of the selected models illustrating the overlap between Behaviour Change literature disengagement factors

Emergent Factors	**1.HBM**	**2.INT**	**3.IMS**	**4.PPTNA**	**5.WMTENA**	**1.IIM**	**2.MTPHB**	**3.PSDM**	**4.MUEOI**
Ability		✓	✓	(✓)	(✓)	(✓)		✓	✓
Age	✓	✓	✓	✓		✓		(✓)	
Behaviour/Treatment - Barriers (Perceived)	✓	(✓)	✓	(✓)	(✓)	✓			
Behaviour/Treatment - Benefits (Perceived)	✓	(✓)	✓	(✓)		✓			
Behaviour/Treatment - Cues to Action	✓		✓						
Behaviour/Treatment - Effectiveness		(✓)	✓	(✓)		(✓)		(✓)	
Behaviour/Treatment - Environmental Constraints		✓	(✓)	(✓)					
Behaviour/Treatment - Intention		✓	✓			✓	✓	✓	
Behaviour/Treatment - Motivation		(✓)	✓	(✓)	(✓)	✓	✓	✓	(✓)
Behaviour/Treatment - Past Experiences				✓				✓	✓
Behaviour/Treatment - Perceptions		(✓)	(✓)	✓	(✓)	(✓)	✓	(✓)	(✓)

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Emergent Factors	**1.HBM**	**2.INT**	**3.IMS**	**4.PPTNA**	**5.WMTENA**	**1.IIM**	**2.MTPHB**	**3.PSDM**	**4.MUEOI**
Behaviour/Treatment - Self-efficacy	✓	✓	✓			✓	✓	✓	
Behaviour/Treatment - Side Effects					✓	(✓)		(✓)	
Behaviour/Treatment - Strategy			✓	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)
Behaviour/Treatment - Strategy (Collaborative Development)			(✓)	✓					
Competing Apps & Websites									(✓)
Demographics	(✓)	✓	(✓)	✓		✓		(✓)	✓
Emotions				(✓)	(✓)		(✓)	(✓)	(✓)
Ethnicity	✓	(✓)	(✓)	✓					
Gender	✓	✓		✓		✓		(✓)	
Illness - Perceptions	(✓)	(✓)	✓	(✓)		(✓)			
Intervention - Aesthetics						(✓)	(✓)	(✓)	✓
Intervention - Content			(✓)	(✓)	✓	✓	(✓)	(✓)	(✓)
Intervention - Content Delivery						✓		(✓)	✓
Intervention - Credibility						✓		✓	✓
Intervention - Expectations						✓		(✓)	✓
Intervention - Feedback						✓	✓	✓	✓

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Emergent Factors	**1.HBM**	**2.INT**	**3.IMS**	**4.PPTNA**	**5.WMTENA**	**1.IIM**	**2.MTPHB**	**3.PSDM**	**4.MUEOI**
Intervention - Interactivity						✓	✓	(✓)	(✓)
Intervention - Navigation						✓	✓	(✓)	
Intervention - Notifications						(✓)	(✓)	(✓)	(✓)
Intervention - Social Network							✓	✓	
Intervention - Tailoring						✓	(✓)	✓	✓
Intervention - Usability						(✓)	(✓)	(✓)	✓
Intervention - Usefulness								✓	
Knowledge	✓		✓		(✓)	✓		✓	
Personality	✓	✓		(✓)		✓		✓	
Psychosocial			✓	(✓)	(✓)	(✓)		(✓)	✓
Self-efficacy - Technical							✓		(✓)
Skills		✓			✓	✓	(✓)	✓	(✓)
Skills - Technical						✓	(✓)		(✓)
Social Norms		✓	✓	✓				✓	
Socio-economic	✓	✓	✓	✓		✓			
Stage of Change						✓			
Support - Family & Friends			✓	(✓)		✓			
Support - Healthcare Professional			(✓)	(✓)	(✓)	✓		(✓)	(✓)
Support - Intervention Design							(✓)	(✓)	
Support - Other Users							✓	(✓)	

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Emergent Factors	**1.HBM**	**2.INT**	**3.IMS**	**4.PPTNA**	**5.WMTENA**	**1.IIM**	**2.MTPHB**	**3.PSDM**	**4.MUEOI**
Usage - Barriers						✓			✓
Usage - Context						(✓)		✓	(✓)
Usage - Experience						(✓)	(✓)	✓	(✓)
Usage - Intention						✓	✓		
Usage - Internet Access						✓			✓
Usage - Motivation							(✓)		✓
Usage - Time									✓

Appendix B

Human-Computer Interaction Literature

Table B.1: 'Features of the Components of User Experience (CUE) Model' taken from Personal Communications with Professor Thüring

Component	Examples
Users	• their mental model of the structure and functionality of the system • their attitudes and expectations even before the first their current state, such as mood, activation level, vigilance, etc. • their usage mode and goals • as well as their personality traits
Contextual factors	• the physical environment of usage (stationary, indoors, mobile, outdoors, etc.) • the social environment (the workplace, at home, etc.), • the task (if any) the system is used for • as well as temporal aspects, such as duration of usage and time pressure
Instrumental qualities	• the usefulness of the system (i.e., the appropriateness of its functionality for the tasks the user is concerned with) • its usability (i.e., the extent it helps the user to complete his tasks effectively, efficiently and satisfactorily) • safety and security characteristics
Non-instrumental qualities	• aesthetic features (visual aesthetics, haptic quality) • status • commitment

Table B.2: Summary table of the selected models illustrating the overlap between Human-Computer Interaction (HCI) literature disengagement factors

Emergent Factors	**1.TAMs**	**2.TAMM**	**3.UTAUTs**	**1.MoE**	**2.MoEN**	**3.MCFIUE**	**1.ToE**	**2.MoUE**	**3.CUE**	**4.MoQA**
Ability				✓					✓	
Age			✓							
Competing Apps & Websites	(✓)			(✓)				(✓)	(✓)	
Demographics	(✓)								(✓)	
Emotions				(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	
Gender			✓							
Image	✓									
Intervention - Aesthetics				✓		✓	(✓)	(✓)	✓	✓
Intervention - Brand					✓					✓
Intervention - Challenge				✓						
Intervention - Content		✓		✓				✓		✓
Intervention - Control		✓		✓				(✓)	(✓)	
Intervention - Ease of Adoption (Perceived)		✓								
Intervention - Effectiveness	(✓)	(✓)		✓				(✓)	✓	✓

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Emergent Factors	**1.TAMs**	**2.TAMM**	**3.UTAUTs**	**1.MoE**	**2.MoEN**	**3.MCFIUE**	**1.ToE**	**2.MoUE**	**3.CUE**	**4.MoQA**
Intervention - Enjoyment (Perceived)	✓		(✓)	✓	✓	(✓)	(✓)	(✓)		
Intervention - Expectations	(✓)			✓				✓	✓	✓
Intervention - Feedback				✓						
Intervention - Fun				✓	✓					
Intervention - Functionality		(✓)			✓		(✓)	✓	✓	✓
Intervention - Interactivity		✓		✓		✓	(✓)	(✓)		(✓)
Intervention - Interest				✓		✓		(✓)		
Intervention - Judgement						✓	(✓)	✓	✓	✓
Intervention - Navigation		✓				(✓)				
Intervention - Novelty				(✓)		✓		✓		
Intervention - Perceptions	(✓)		(✓)		(✓)	(✓)	(✓)	(✓)	✓	(✓)
Intervention - Sensory							(✓)			
Intervention - Social Network		(✓)		(✓)	(✓)					

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Emergent Factors	**1.TAMs**	**2.TAMM**	**3.UTAUTs**	**1.MoE**	**2.MoEN**	**3.MCFIUE**	**1.ToE**	**2.MoUE**	**3.CUE**	**4.MoQA**
Intervention - Tailoring		(✓)		✓						(✓)
Intervention - Trust		✓						(✓)	(✓)	
Intervention - Usability	(✓)	(✓)	(✓)	✓	(✓)	✓	(✓)	✓	✓	✓
Intervention - Usefulness	✓	(✓)	(✓)		✓		(✓)	✓	✓	(✓)
Intervention - Value (Perceived)		✓	(✓)		✓		(✓)			
Intervention - Voluntariness of Use	✓		(✓)							
Knowledge								(✓)	✓	
Personality	(✓)						(✓)		✓	
Psychosocial					(✓)		(✓)		(✓)	
Self-efficacy - Technical	(✓)									
Self-identity							(✓)	(✓)	(✓)	
Skills								(✓)	✓	
Skills - Technical									(✓)	
Social Norms	(✓)		(✓)							
Support	✓	✓	(✓)							
Support - Intervention Design								✓		

Continues on the next page ...

Emergent Factors	**1.TAMs**	**2.TAMM**	**3.UTAUTs**	**1.MoE**	**2.MoEN**	**3.MCFIUE**	**1.ToE**	**2.MoUE**	**3.CUE**	**4.MoQA**
Usage - Attention				✓		✓	(✓)	(✓)		
Usage - Awareness				✓			(✓)			
Usage - Barriers	(✓)		(✓)							
Usage - Context				(✓)			(✓)	(✓)	✓	
Usage - Efficiency					✓			✓	✓	✓
Usage - Emotions	(✓)			(✓)		✓	(✓)	✓	✓	
Usage - Engagement										✓
Usage - Experience				✓		✓	(✓)	(✓)		✓
Usage - Facilitators	(✓)		(✓)							
Usage - Goals				✓		✓	(✓)	✓	(✓)	✓
Usage - Habit			✓							
Usage - Intention	✓	✓	✓	✓	(✓)		(✓)	(✓)	(✓)	✓
Usage - Interruptions				✓						
Usage - Job Relevance	✓									
Usage - Location							(✓)		(✓)	
Usage - Motivation	(✓)			✓	✓			(✓)		
Usage - Motivation (Hedonic)	(✓)		✓		✓					
Usage - Motivation (Social)					✓					
Usage - Motivation (Utilitarian)					✓					

Continues on the next page ...

Emergent Factors	**1.TAMs**	**2.TAMM**	**3.UTAUTs**	**1.MoE**	**2.MoEN**	**3.MCFIUE**	**1.ToE**	**2.MoUE**	**3.CUE**	**4.MoQA**
Usage - Past Experiences	(✓)		(✓)	✓		(✓)	✓	(✓)		✓
Usage - Satisfaction					✓			✓	✓	✓
Usage - Time				(✓)			(✓)	(✓)	(✓)	
User's Background										✓

Appendix C

Framework

Table C.1: Literature factors that were not included in the DisENGAGE framework

Original Factor	**Explanation or Related Factor**
Behaviour/Treatment - Environmental Constraints	Behaviour/Treatment - Barriers
Behaviour/Treatment - Strategy (Collaborative Development)	Intervention - Strategy, Support - Healthcare Professional
Intervention - Content Delivery	Intervention - Content
Self-efficacy - Technical	Skills - Technical
Image	Individual - Self-identity
Intervention - Brand	N/A in research setting
Intervention - Fun	Intervention - Enjoyment
Intervention - Presentation	Intervention - Aesthetics, Intervention - Interactivity
Intervention - Social Network	Intervention - Social
Intervention - Usefulness	Intervention - Effectiveness
Intervention - Value (Perceived)	Intervention - Judgement
Usage - Attention	Type of Engagement (too specific)
Usage - Awareness	Type of Engagement (too specific)
Usage - Efficiency	Intervention - Effectiveness
Usage - Engagement	Ambiguous term
Usage - Experience	Usage, Usage - Past Experience
Usage - Interruptions	Usage - Barriers
Usage - Job Relevance	Usage - Goals
Usage - Motivation (Hedonic)	Intervention - Enjoyment
Usage - Motivation (Social)	Intervention - Social
Usage - Motivation (Utilitarian)	Intervention - Effectiveness
Usage - Satisfaction	Intervention - Judgement

Appendix D

PRIMIT

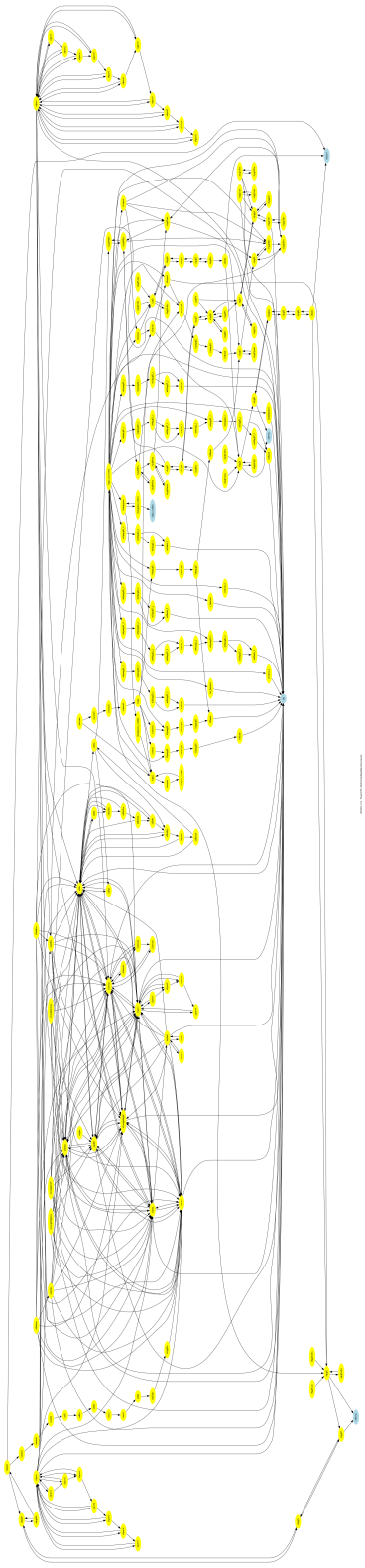

Figure D.1: Primit architecture

Table D.1: PRIMIT session content (taken from the Appendix of Little *et al.* (2015))

Session	**Content**
Session 1	• Details of the medical team (enhancing credibility). • Information about: – The importance of preventing seasonal and pandemic flu. – How viruses are transmitted. – The role of hand washing in interrupting transmission. • Questions about the participant's current hand washing habits in different situations. • Completion of a plan to set hand washing goals (intention formation). Participants could access and update this plan throughout the intervention. • Automated personalised feedback on the plan. • Provision of a printable version of the plan and encouragement to sign and display this in a prominent place to involve other household members. • Information about collecting a free hand gel from the GP surgery.
Session 2	• Tailored feedback based on participants' perceived benefits and difficulty of hand washing, and intended hand washing (repeated in Sessions 3 and 4). • True or false quiz about cold and flu facts. • Information about cleanliness perceptions (dirt is not always visible). • Evidence of the effectiveness of hand washing. • Expert recommendations for frequency of hand washing. • Information about specific situations where hand washing is important. • Information about making hand washing a habit.
Session 3	• True or false quiz about hand washing facts (addressing negative beliefs). • Expert recommendations for hand washing techniques. • Information about transmission caused by touching your face. • Information about where germs are prevalent. • Information about the transmission of viruses from person to person. • Overcoming barriers to hand washing (time, dry hands).
Session 4	• Raising benefit perceptions of hand washing. • Reinforcing hand washing as a social norm. • True or false quiz about cold and flu facts. • Evidence and information about the importance of hand washing for children.
Other information (optional)	• Links to relevant websites, to printable posters and wall charts. • Information about the experts involved in the creation of PRIMIT. • Extra information about flu. • Advice on how to reduce infection transmission using methods other than hand-washing (e.g. through social distancing).

Table D.2: A frequency table of Q2 ratings

Rating	**Session**			
	1	**2**	**3**	**4**
1	93 (1.05%)	77 (1.16%)	67 (1.24%)	61 (1.26%)
2	113 (1.28%)	101 (1.52%)	90 (1.66%)	83 (1.71%)
3	92 (1.04%)	83 (1.25%)	66 (1.22%)	59 (1.21%)
3.5	1 (0.01%)	1 (0.02%)	1 (0.02%)	1 (0.02%)
4	274 (3.1%)	216 (3.25%)	180 (3.33%)	163 (3.36%)
5	457 (5.17%)	408 (6.15%)	358 (6.62%)	330 (6.79%)
6	813 (9.19%)	740 (11.15%)	676 (12.49%)	635 (13.07%)
6.5	3 (0.03%)	3 (0.05%)	3 (0.06%)	3 (0.06%)
7	1364 (15.42%)	1286 (19.38%)	1185 (21.9%)	1119 (23.04%)
NA	5633 (63.7%)	3721 (56.07%)	2785 (51.47%)	2403 (49.47%)
Total	8843 (100%)	6636 (100%)	5411 (100%)	4857 (100%)

Table D.3: A frequency table of Q3 ratings

Rating	**Session**			
	1	**2**	**3**	**4**
1	88 (1%)	78 (1.18%)	68 (1.26%)	65 (1.34%)
2	74 (0.84%)	68 (1.02%)	60 (1.11%)	57 (1.17%)
3	29 (0.33%)	26 (0.39%)	23 (0.43%)	21 (0.43%)
4	222 (2.51%)	171 (2.58%)	146 (2.7%)	133 (2.74%)
4.5	1 (0.01%)	1 (0.02%)	1 (0.02%)	1 (0.02%)
5	316 (3.57%)	271 (4.08%)	234 (4.32%)	215 (4.43%)
5.5	2 (0.02%)	2 (0.03%)	2 (0.04%)	2 (0.04%)
6	811 (9.17%)	741 (11.17%)	666 (12.31%)	620 (12.77%)
6.5	2 (0.02%)	2 (0.03%)	2 (0.04%)	2 (0.04%)
7	1659 (18.76%)	1551 (23.37%)	1418 (26.21%)	1331 (27.4%)
NA	5639 (63.77%)	3725 (56.13%)	2791 (51.58%)	2410 (49.62%)
Total	8843 (100%)	6636 (100%)	5411 (100%)	4857 (100%)

Table D.4: A table to show the loss of users between sessions (Q2), grouped by rating

Rating	**Loss Between Sessions**		
	1 & 2	**2 & 3**	**3 & 4**
1	93-77=16 (3%)	77-67=10 (3%)	67-61=6 (4%)
2	113-101=12 (4%)	101-90=11 (3%)	90-83=7 (4%)
3	92-83=9 (3%)	83-66=17 (4%)	66-59=7 (2%)
4	274-216=58 (21%)	216-180=36 (12%)	180-163=17 (10%)
5	457-408=49 (17%)	408-358=50 (17%)	358-330=28 (13%)
6	813-740=73 (22%)	740-676=64 (22%)	676-635=41 (26%)
7	1364-1286=78 (29%)	1286-1185=101 (38%)	1185-1119=66 (40%)
Total	295 (100%)	289 (100%)	172 (100%)

Table D.5: A table to show the loss of users between sessions (Q3), grouped by rating

Rating	**Loss Between Sessions**		
	1 & 2	**2 & 3**	**3 & 4**
1	88-78=10 (5%)	78-68=10 (3%)	68-65=3 (3%)
2	74-68=6 (4%)	68-60=8 (4%)	60-57=3 (4%)
3	29-26=3 (3%)	26-23=3 (6%)	23-21=2 (4%)
4	222-171=51 (20%)	171-146=25 (12%)	146-133=13 (10%)
5	316-271=45 (17%)	271-234=37 (17%)	234-215=19 (16%)
6	811-741=70 (25%)	741-666=75 (22%)	666-620=46 (24%)
7	1659-1551=108 (26%)	1551-1418=133 (35%)	1418-1331=87 (38%)
Total	293 (100%)	291 (100%)	173 (100%)

Table D.6: A table to show the proportions of remaining users at each session, grouped by Q2 rating

Rating	**Session**			
	1	**2**	**3**	**4**
1	93/93=1	77/93=0.828	67/93=0.720	61/93=0.656
2	113/113=1	101/113=0.894	90/113=0.796	83/113=0.735
3	92/92=1	83/92=0.902	66/92=0.717	59/92=0.641
4	274/274=1	216/274=0.788	180/274=0.657	163/274=0.595
5	457/457=1	408/457=0.893	358/457=0.783	330/457=0.722
6	813/813=1	740/813=0.910	676/813=0.831	635/813=0.781
7	1364/1364=1	1286/1364=0.943	1185/1364=0.869	1119/1364=0.820
NA	5633/5633=1	3721/5633=0.661	2785/5633=0.494	2403/5633=0.427

Table D.7: A table to show the proportions of remaining users at each session, grouped by Q3 rating

Rating	**Session**			
	1	**2**	**3**	**4**
1	88/88=1	78/88=0.886	68/88=0.773	65/88=0.739
2	74/74=1	68/74=0.919	60/74=0.811	57/74=0.770
3	29/29=1	26/29=0.897	23/29=0.793	21/29=0.724
4	222/222=1	171/222=0.770	146/222=0.658	133/222=0.599
5	316/316=1	271/316=0.858	234/316=0.741	215/316=0.680
6	811/811=1	741/811=0.914	666/811=0.821	620/811=0.764
7	1659/1659=1	1551/1659=0.935	1418/1659=0.855	1331/1659=0.802
NA	5639/5639=1	3725/5639=0.661	2791/5639=0.495	2410/5639=0.427

Table D.8: The number of participants who did or did not provide a rating for Q2

Group	**Session**			
	1	**2**	**3**	**4**
Raters	3206 (36%)	2911 (44%)	2622 (48%)	2450 (50%)
NA	5633 (74%)	3721 (56%)	2785 (52%)	2403 (50%)
Total	8839 (100%)	6632 (100%)	5407 (100%)	4853 (100%)

Table D.9: The number of participants who did or did not provide a rating for Q3

Group	**Session**			
	1	**2**	**3**	**4**
Raters	3199 (36%)	2906 (44%)	2615 (48%)	2442 (50%)
NA	5639 (64%)	3725 (56%)	2791 (52%)	2410 (50%)
Total	8838 (100%)	6631 (100%)	5406 (100%)	4852 (100%)

Table D.10: The number of participants that dropped out, grouped by raters and *NA* for Q2

Group	**Loss Between Sessions**		
	1 & 2	**2 & 3**	**3 & 4**
Raters	3206-2911=295 (13%)	2911-2622=289 (24%)	2622-2450=172 (31%)
NA	5633-3721=1912 (87%)	3721-2785=936 (76%)	2785-2403=382 (69%)
Total	2207 (100%)	1225 (100%)	554 (100%)

Table D.11: The number of participants that dropped out, grouped by raters and *NA* for Q3

Group	**Loss Between Sessions**		
	1 & 2	**2 & 3**	**3 & 4**
Raters	3199-2906=293 (13%)	2906-2615=291 (24%)	2615-2442=173 (31%)
NA	5639-3725=1914 (87%)	3725-2791=934 (76%)	2791-2410=381 (69%)
Total	2207 (100%)	1225 (100%)	554 (100%)

Table D.12: A table to show the proportion (percentage) of raters and *NA* who dropped out of their respective group populations

Group		**Loss Between Sessions From Group**		
		1 & 2	**2 & 3**	**3 & 4**
Q1	Raters	298/3218=0.0926 (9%)	290/2920=0.0993 (10%)	174/2630=0.0662 (7%)
	NA	1909/5621=0.340 (34%)	935/3712=0.252 (25%)	380/2777=0.137 (14%)
Q2	Raters	295/3206=0.0920 (9%)	289/2911=0.0993 (10%)	172/2622=0.0656 (7%)
	NA	1912/5633=0.339 (34%)	936/3721=0.252 (25%)	382/2785=0.137 (14%)
Q3	Raters	293/3199=0.0916 (9%)	291/2906=0.100 (10%)	173/2615=0.0662 (7%)
	NA	1914/5639=0.339 (34%)	934/3725=0.251 (25%)	381/2791=0.137 (14%)

Appendix E

CIRCA

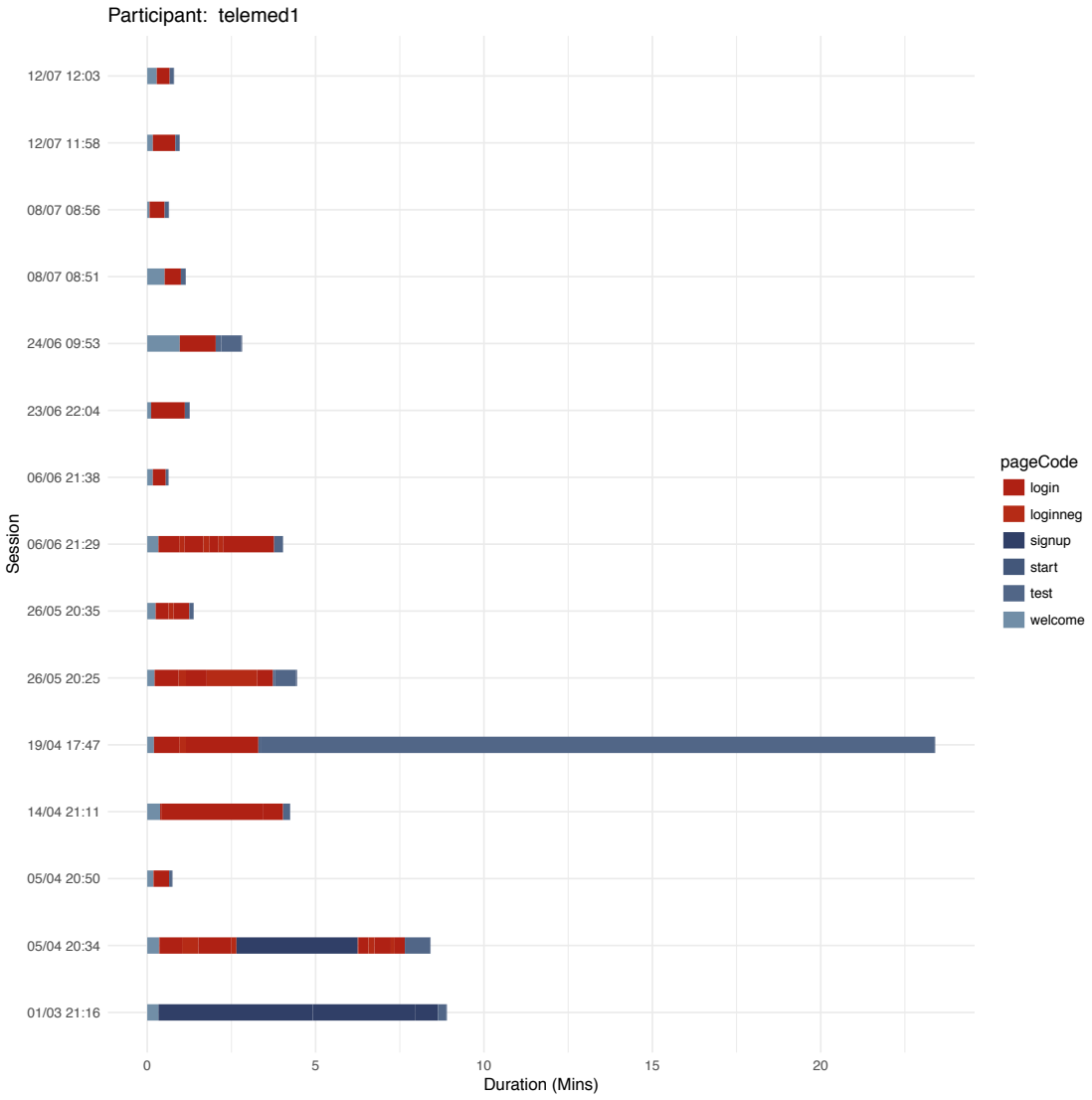

Figure E.1: Page flow graph showing each of Telemed1's sessions and the pages visited

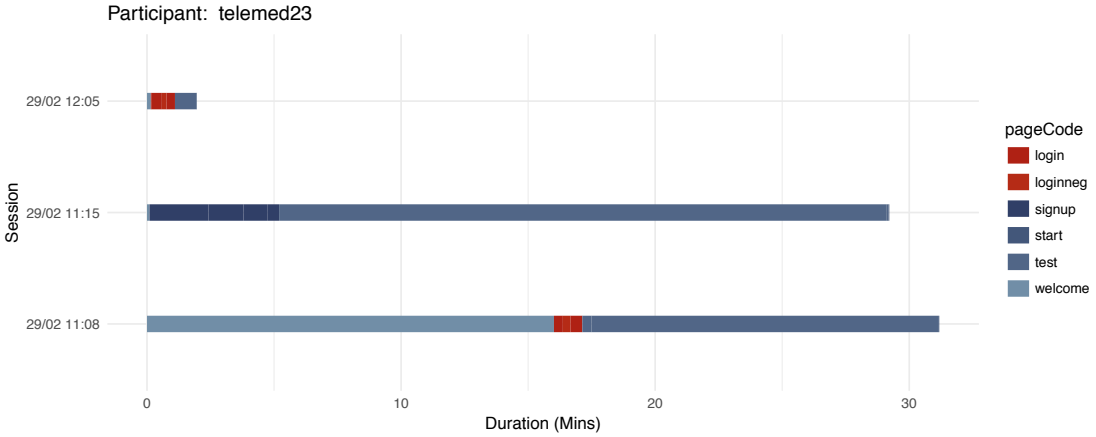

Figure E.2: Page flow graph showing each of Telemed23's sessions and the pages visited

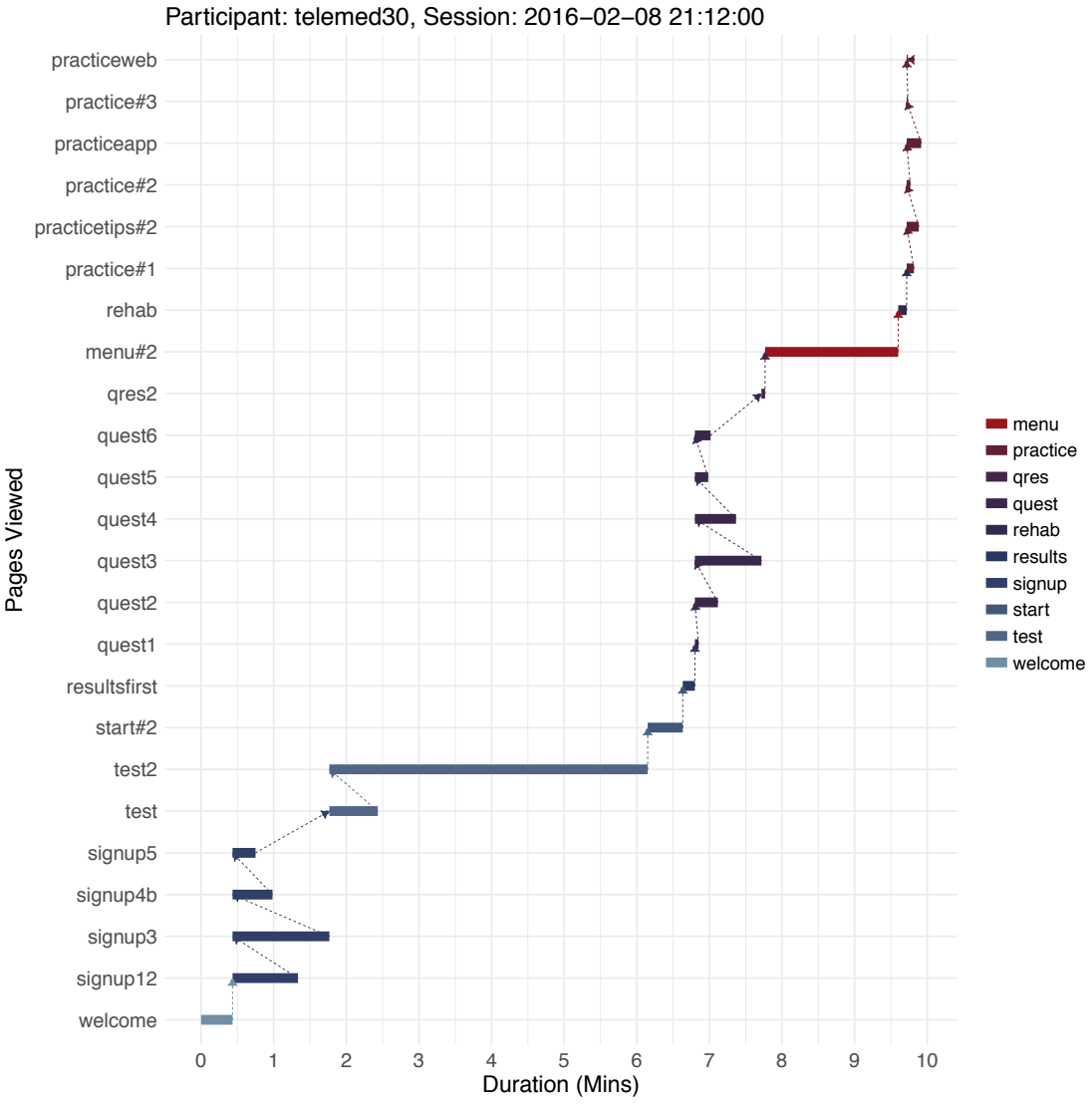

Figure E.3: Page flow graph of Telemed30's session

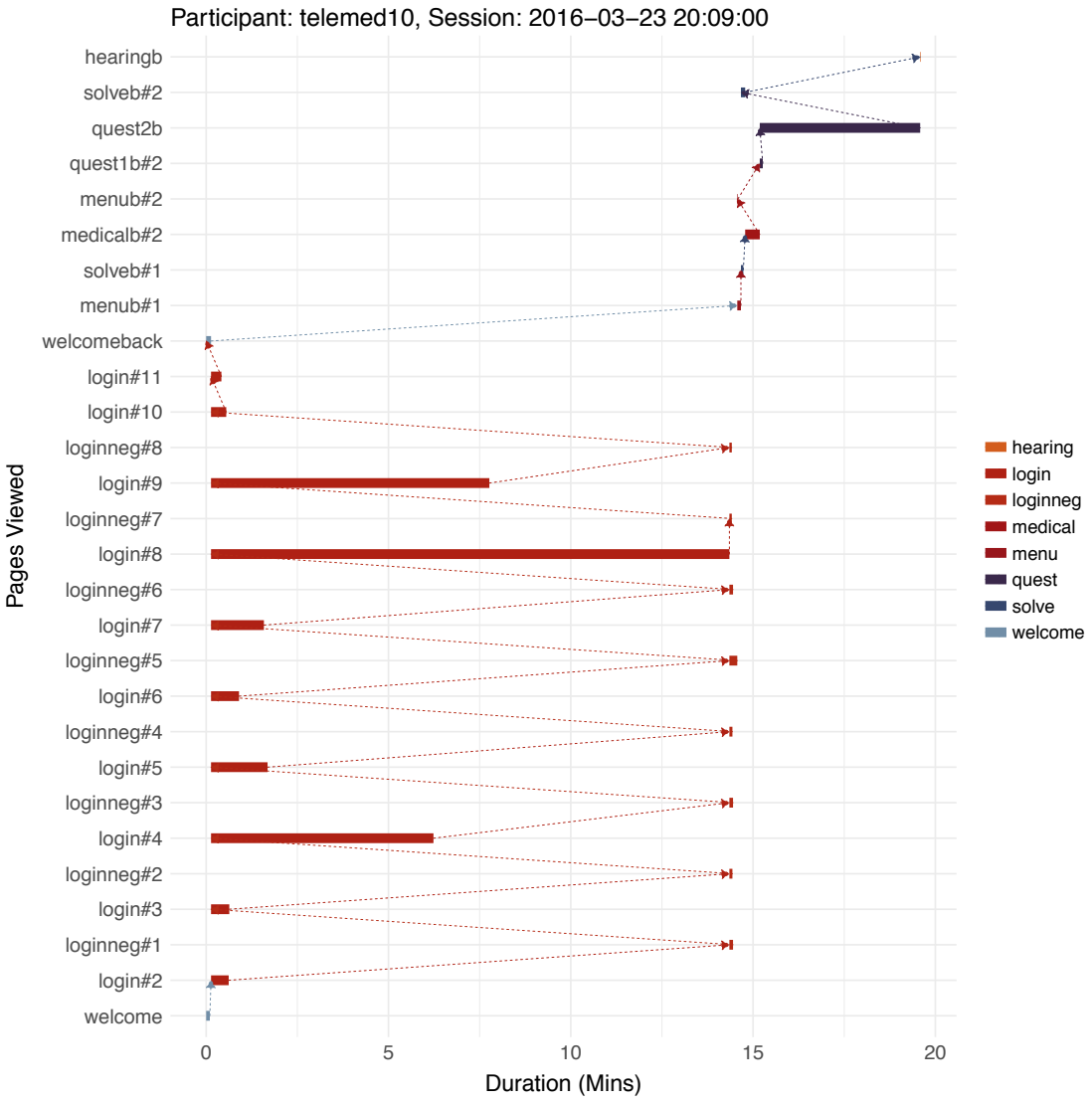

Figure E.4: Page flow graph of Telemed10's 4th Session

Appendix F

Getting Active

Table F.1: Getting Active (Stage 1): Participant information

Assigned Name	Age	Gender
Mike	45	Male
Beth	29	Female
Cara	33	Female
John	39	Male
Zoe	24	Female
Melissa	37	Female

Table F.2: Getting Active (Stage 2): Participant information

Participant Number	Assigned Name	Age	Gender
16136	Becky	36	Female
16222	Maggie	77	Female
16225	Faye	22	Female
17896	Jacobe	29	Male
17950	Eva	68	Female
17988	Fraser	32	Male
18004	Lena	27	Female
18081	James	33	Male
18082	Grace	59	Female
18108	Amelia	33	Female
18139	Katie	34	Female
29217	Mia	57	Female
29382	Christoph	26	Male

F.1 Think-aloud Interview Guide

Getting Active for Health (Asthma)-Think-aloud interview flow

Contents:

1. Introduction
2. Pre-think aloud questions incl. questions relevant to perceptions of psychological aspects of asthma and asthma control.
3. Think aloud instructions
4. Questions about the overall intervention after testing

1. Introduction

Interviewer: Before starting, set up their computer/my laptop with the website.

So in this study we want to find out what people think about a website (Getting Active) that we developed to help people with asthma to be more active. This website is part of a programme called 'My Breathing Matters'. Today, I will show you the programme and ask you to tell me about what you think of it. I will also ask you a bit about your asthma.

You can choose not to take part at any time. If you want to withdraw at any time and not take part anymore, please just let me know. If you are happy, we will record the interview on here, so we can listen again to what is being said. We will not keep anything on record that identifies you, or where you live or anyone else that you mention, so it will all be anonymous. Also, everything we talk about here will be confidential.

We can take a break at any time you like, please just let me know and I can pause the recording. We can also stop the interview at any time if you want to.

Please go carefully through the information sheet (if you haven't done it yet).

Ok so do you have any questions? If you are happy, please complete this consent form before we start recording.

First, please fill up these short questionnaires.

Now, I'd like to have a chat with you about your views on your asthma.

Interviewer: The following questions are examples; they will be subject to change, in accordance with knowledge gained from interviews and subsequent website development.

2. Pre-think aloud questions (Questions relevant to perceptions of psychological aspects of asthma and asthma control)

Interviewer: Don't ask if they have done MBM.

- Can you tell me about what it is like to have asthma?
- How did you feel when you were first told you had asthma?
- Can you tell me about any ways that your asthma interferes with what you want to do?
- Can you tell me about any ways you stop asthma interfering with what you want to do?
- Can you tell me about any times that asthma has affected how you feel or created a stressful situation?
- Can you tell me about any times that how you are feeling or a stressful situation has affected your asthma?
- Can you talk me through what (if anything) you currently do that helps your asthma?
- Can you tell me about how your GP and practice nurse are helping you with your asthma?
- Can you tell me about whether anyone else helps you with your asthma?
- Can you tell me about anything that you've ever looked at on the internet to get advice on living with asthma?
  - What did you like about this advice/information?
  - What did you dislike?
  - Thinking about what you viewed on the internet, can you tell me about any changes that you made to how you manage asthma based on this?
- Can you tell me about any other information (not on the internet) that you've ever used to help you with your asthma?
  - What did you like about this advice/information?
  - What did you dislike?
  - Can you tell me about any changes that you made to how you manage your asthma based on this information?

3. Think Aloud Instructions

Interviewer: The flow of the think-aloud interview is as follows:

1. Think aloud of the introductory pages

Optional (if needed)

2. Think aloud of the My Progress pages
3. Think aloud of the My Messages and My Support pages
4. Follow-up questions

OK, so I will tell you a little more about what we will be doing today.

All you have to do is use the website as you would if I was not here, and say your thoughts out loud. This is not a test and there are no right or wrong answers, so please

say any thoughts which spring to mind, even if you think they might not be important. Please do feel free to say negative thoughts you may have about the programme and the advice it gives your feedback will help us improve it.

I won't be able to answer your questions as we go through, but I can answer anything at the end. So if you ask me a question while you're looking at the programme, I will probably say that we can talk about it at the end. I will also remind you to think-aloud because it is something that is very easy to forget. You may find at times I will say aloud what you have clicked on or what page you are looking at this is just so when we listen to your views again we know what page you are talking about.

Before we start let's just have a quick think-aloud practice. So, in your mind walk through your home and count the windows in every room and think out loud [e.g. 'So, I'm now in the kitchen and there is 1 window above the sink. Now I walk to the bathroom and I'm feeling a bit weird saying this out loud...and now I'm in the bathroom...'].

Interviewer: Prompts for think aloud, and say the page names [also remind people to think aloud if they forget]

- (only on first page) What are your first impressions of this page?
- What are you thinking now?
- What made you choose that option?
- What do you think about [this activity, this information, empowerment tool]?
- Can you tell me a bit more about why you think that?
- What is it you like about that?
- That's really interesting ...
- Mmmmm

4. Questions after testing (follow ups):

- Overall, how do you feel about the Getting Active programme?
- Can you tell me about anything you liked about the pages?
  - Did you have a favourite part of it? Why was it your favourite?
  - Did you have a least-favourite part? Why was it your least favourite?
- Was there anything you found surprising?
- Can you tell me anything about the pages that you were less keen on?
- Can you tell about anything that you think should be changed (if you think something should be changed)?

Interviewer: These are additional questions to be asked after the last think aloud.

- Can you tell me about anything else that you think might be useful to you?
- Which parts did you find most relevant to you?
- Which aspects of the Getting Active would you recommend to other people?

- How would you feel if your GP or practice nurse asked you to use the Getting Active website?
- PA specific [looking at if website might help them doing more PA].
- After seeing the Getting Active website how do you feel about doing more physical activity?
- Probe: Can you tell me about anything that might get in the way of any physical activity you might do?
- Probe: Can you think of anything that could make it easier for you to do more PA?

F.2 Retrospective Usage Interview Guide (Final Version)

Participant Number:

I haven't started recording yet.

Just before we start there are a couple of things I would like to go over, if that's ok with you?

Did you read the participant information sheet? Do you want to read it again?

I want to emphasise that there are **no right or wrong answers** to any of these questions. Please just answer the questions however you feel is appropriate and **please say anything that comes to mind**, even if you don't think it is important. Also free to ask me to clarify anything you don't understand. I would also like to state that I did not design or develop this website and therefore **I will not be offended by anything that you say**.

We can **take a break at any time**, just let me know and I can pause the recording. We can also **stop the interview** and you can withdraw from the process at any time.

I will be recording the interview so that I can listen back to it later.

There are just a few pieces of information that I will ask for before we start the interview.

General Info:

1. Age
2. Age of diagnosis
3. Gender
4. Profession/Background

Are you happy with everything we have discussed? Do you have any questions?

Did you use a log book or write any notes during the two weeks? Could you get those now please?

I still have your written consent form but I just want to confirm that you are happy to continue.

I will start the recording then.

State participant number.

Exp

1. **How often** do you use the internet and for **what type of thing**?
   - If say work, do you use social media etc?
2. Can you describe any **other sites/apps** that you have used that are similar to Getting Active?
3. Could you tell me about any **expectations** that you had of the website before use or the first time you used it?
   - What did you think it was for?
   - What was its main purpose?

Int

4. What **device** did you use to access the site?
5. Which **browser** did you use?
6. Can you talk me through **where and when** you tended to use the website?

Overall Impression

7. Can you give me an overview of **what you thought** of Getting Active?
   - How would you describe it?
   - What features did you particularly use?
8. What did you find out that you didn't already know?
9. Can you tell me anything you **liked** about the website?
   - What did you **like most**?
10. Can you tell me anything you **disliked**?
    - What did you **dislike most**?

Goal Setting

11. How did you use the **goal setting** section of the website?
    - Did you **achieve** your **goals**?
12. Did you **print** your **goals**?

- Why?

13. What did you think of the **stars**?
    - Were you awarded any?
    - Did you see them?
14. Is there anything else that would have enticed you to use it?
15. Is there anything else you would have liked to track?

Success Stories

16. How did you feel about the success stories?
    - How applicable did you think they were to you?

Quiz

17. What did you think about the quiz?

Navigation

18. Talk me through what it was like **navigating** around the website
    - Did you stop around any particular section?
    - If someone didn't look at a particular section
        - One of the features you didn't look at was X – do you know why you didn't click on it?
        - Do you think that would have found the content in X useful?
            * If yes then what do you think we could have done to make you look at that?
19. What did you think of the **locked sections**?

Design

20. Can you tell me what you thought of the **look** and **design** of the website?
    - (Pictures / Colours / Fonts)

Messages

21. How did you set up the messages from Getting Active?
    - How often did you receive them?
    - Did you find them useful?

Activity

22. Can you tell me about **any changes** that you've made since using Getting Active?

- How did **Getting Active** help you **achieve** this?

23. How active were you before this study?
    - Have you noticed a **change** in activity levels since using Getting Active?
    - Why do you think this has changed?
24. Which, if any, **activity trackers** do you use?

Support

25. What **type of support** do you receive for your asthma?
26. Can you describe **any medication** that you use for your asthma?
    - Is there anything in getting active that you've read that questions your attitude towards running?

Usage

27. How many times did you use GA?
    - Was there something that prompted you to use it at those times?
    - Any reason you didn't use it more?

Personalised

28. Did you explore the My Support section?
    - Why was this?

Sum

29. How do you think you would use this website in **the future**?
    - Do you think you would actually use this in a real-world situation?
      - Do you think you will continue with these activities even though you aren't still using the website?

Disengagement

One of the things I m actually interested in is why people **stop using sites**.

- Is there **anything else** you would like to tell me or discuss with this in mind?
- Is there anything else that you have **written down**?

F.3 Codebooks

Table F.3: Getting Active (Stage 1): 'Individual' DisENGAGE Codebook

Code Label	Description	Example Quote
1. Personality characteristics	A reference to the individual's personality, character, or nature	• I'm just being suspicious [Mike (ln 342)]
2. Skills	A reference to an individual's ability, including their professional skills, and literacy levels	• I'm a scientist, I quite like facts [Cara (ln 507)]

Table F.4: Getting Active (Stage 1): 'Intervention' DisENGAGE Codebook

Code Label	**Description**	**Example Quote**
1. User experience (UX)	Comments relating to a user's experience or interaction with technology, including comments relating to the intervention	
1.1. Intervention features	Comments relating to the user interface, interactions with the system, feelings about the intervention or usage, usage, and expectations	
1.1.1. Aesthetics	Any comments relating to the look of the interface, including graphics, colour schemes and layout	
1.1.1.1. Positive	Positive comments relating to the look of the intervention	
1.1.1.1.1. Use of graphics	A positive comment regarding the images or photos used within the intervention	• The thumbs up man is quite sweet [Mike (ln 167-168) • I like that graphic [Beth (ln 443)]
1.1.1.1.2. Layout	A positive comment relating to the layout of the user interface, including the location of buttons, tabs and images	• Overall, [the intervention is] good. It's clean and simple, and not cluttered [Beth (ln 648)] • It's a simple layout [Zoe (ln 287)]
1.1.1.1.3. Colours	A positive comment relating to the colour scheme of the intervention	• The colour scheme, I really like it. It's nice and calming, which I assume was the point of using blue [Beth (ln 651-653)] • I like the colour of the screen, it reminds me of asthma for some reason, the blue colours. I don't know if that's because of the inhalers and things I've seen before [Melissa (ln 307-308)]

Code Label	Description	Example Quote
1.1.1.1.4. Font	A positive comment relating to the type of styling of the font used within the intervention	• I like how you've got poignant words in bold, like stronger, less strain, rebuild themselves, and things like that. It just reinforces the fact that it's a benefit [Zoe (ln 268-269)] • So I like the welcome screen, it's a nice, big bold font [Melissa (ln 2)]
1.1.1.2. Negative	Negative comments relating to the look of the intervention	
1.1.1.2.1. Use of graphics	A negative comment regarding the use of graphics within the intervention	• The picture doesn't look very active [Cara (ln 189)] • Yes, I'm not sure how the icon for this one relates to the button, but the icon is a little guy standing on some pills, but then it says, I want to find out about some feelings, on the text [ln 462-464]
1.1.1.2.2. Layout	A negative comment relating to the layout of the user interface, including the location of buttons, tabs and images	• I would have [the tabs] on the left, but that's just me, because that's where I always look [Zoe (ln 295-296)]
1.1.1.2.3. Text looks like a link	A negative comment regarding how the look of the text implies it is a link	• I'd expect this to be a link, because it's a different text, so I don't know why it's a different text, if it's not a link [Mike (ln 390-392)] • Okay, I didn't know if the different colours there were because it was a link to click, or if it was just the style [John (ln 173-175)]

Code Label	Description	Example Quote
1.1.1.2.4. Other	Additional negative comments that do not fit under any of the other labels	• [Reasons for being active are good] maybe they should be in bold somewhere as well, or higher up [Cara (ln 387)] • That looks weird, adjust, it's like a lighter colour and then there's a space between it [Melissa (ln 200-201)]
1.1.1.3. Suggestion	A suggestion about the aesthetics of the intervention	• If there was a picture of that person, it would give more a bit more confidence [Mike (ln 349-350)] • I'm sure that those would be perhaps better with a little logo of some sort [John (ln 226-227)]
1.1.2. Content (Text)	Any comment relating to the text-based content of the intervention, including whether the user knows the information and whether they react positively or negatively to the information provided	
1.1.2.1. I know that	Comments relating to the content that an individual already knows	• It's good reminders, but it's all stuff I already know [Mike (ln 582)]
1.1.2.2. Positive	Positive comments relating to the information and text-based content of the site	
1.1.2.2.1. I like that	A comment relating to particular content that the user likes or thinks is good, excludes comments that specifically use the word 'interesting' or relating to novel ideas	• I'm happy with that information [John (ln 186)] • The writing's quite nice, as well [Zoe (ln 290)]

Code Label	Description	Example Quote
1.1.2.2.2. Interesting	A comment that uses the word 'interesting' or states that the content is novel or new, excludes general positive comments	• By using the stairs, it's a great way to do more activity. Okay. They've got one that isn't true. Interesting [Mike (ln 234-235)] • I hadn't thought about that, actually, using YouTube for exercise videos [Beth (ln 375-376)]
1.1.2.2.3. Relatable	A comment relating to the relevance of the content for that particular user, excludes comments regarding hypothetical opinions about other users' thoughts of the content	• I know that this is a probably a test website, and someone's probably just written these, but they are believable, and I can totally see myself in these stories, so it's nice [Beth (ln 604-606)] • Yes, activities like running and cycling, that's quite relevant to me [John (ln 280)]
1.1.2.2.4. Motivational	Comments about text-based content that motivates the user to be more active	• I mean, I know what I should be doing. What that does do is, it helps encourage me, but it didn't tell me anything I didn't already know [Mike (ln 614-616)] • Yes, I think there're a few stories of, as I say, getting and keeping fit, which I've experienced myself, so I was encouraged to read those [John (ln 528-529)]
1.1.2.2.5. Other	Additional positive comments that do not fit under any of the other labels	• It's not a difficult writing to read, or anything like that [Zoe (ln 290-291)]
1.1.2.3. Negative	Negative comments relating to the text-based content of the intervention	

Code Label	Description	Example Quote
1.1.2.3.1. Disinterest	A comment such as disinterest, disengagement, boredom relating to the presented text	• I'm a bit bored now [how can getting active help me] [Mike (ln 274)] • Okay, that's fine. I realise that I can ignore them if I want, which is good [Cara (ln 326)]
1.1.2.3.2. Unclear information/wording	A comment about needing clarity, more detail, or confusion regarding the meaning of the text, excludes comments where the individual understands the meaning of the text	• Trying to understand what [the question] means [Beth (ln 205)] • So, that's just confusing, remembering that that's what they've called it [Beth (ln 530-531)]
1.1.2.3.3. Lack of asthma-specific content	A comment about the lack of asthma-specific content or references on the intervention	• There wasn't much reference to asthma ... if you really want me, as an asthmatic, to do this, I wouldn't necessarily do it, because it's not clear that it's for asthma [Mike (ln 588-591)]
1.1.2.3.4. Repetition	A comment relating to content that the individual feels they have already seen or read before on the intervention	• So this is not just going to say the exact same information that I've seen before? Yes, so I've seen all this [Beth (ln 515-517)]
1.1.2.3.5. Not personally relevant/lack of tailoring	A comment about content that is not relatable or relevant to the individual, including comments relating to the lack of tailoring, static nature of the text-based information	• [It could be] a month down the line, I'm struggling – am I going to get any more information, or am I just going to reread the same stories that I've already read? [Beth (ln 657-659)] • I'm going to skip through these, because I don't have these conditions [John (ln 456)]

Code Label	Description	Example Quote
1.1.2.3.6. Other	Additional negative comments that do not fit under any of the other labels	• Those examples are great, but once you've read them, you've read them, and so it could be that I want more from that section [Beth (ln 669-671)]
1.1.2.4. Credibility	A comment about the credibility or believability of the text-based content	• Is it just a researcher that's trying to fool me into think that's a real person? [Mike (ln 338-339)] • [Safety of getting active] But, yes, I'm convinced, so I guess I'm going to check that it's for me, and see what the difference is [Cara (ln 340-341)]
1.1.2.5. Suggestion	A suggestion about the text-based content of the intervention	• Stick in, 'we'll send you a free step counter' [Mike (ln 366)] • Yes, so yes, just a link to another page. Yes, I don't think you should put all the information on your pages, but if you're really keen [Cara (ln 513-514)]
1.1.2.6. Other	Additional comments about content that are neutral – neither positive or negative	• [Quiz] I'm not sure which to answer there, because I'm thinking sometimes physical activity can be bad for my breathing [ln 185-187)]
1.1.3. Credibility	Any comments relating to the credibility of the intervention, including suggestions	• If there was a picture of that person, it would give more a bit more confidence [Mike (ln 349-350)] • Perhaps different wording, but I think it's ... Yes, it just sounds a little bit made up, that one, in particular. I don't know why [John (ln 434-435)]
1.1.4. Usability	Comments referring to the ease-of-use, efficiency, and accessibility of the system, excluding comments referring to confusion about content	

Code Label	Description	Example Quote
1.1.4.1. Good usability	A positive comment referring to ease-of-use, excluding comments referring to navigation	• Let's go forward. So, I like the fact that it's carried it over, that's excellent [Mike (ln 493-494)]
1.1.4.2. Poor usability	A negative comment referring to ease-of-use, excluding comments referring to navigation	
1.1.4.2.1. Surprise or uncertainty over interaction	A comment questioning the functionality of something on the UI or confusion about what to do, excludes comments specifically referring to the user's expectation or navigation	• There's no link to go back to the homepage. I can't scroll on anything [Beth (ln 554)] • I'm trying to figure out what I need to do next, I guess. I guess I'm thinking, could I sign up for emails, and then I'll have to do the rest of the process, maybe? [...] Okay, so I guess I'm clicking to get started [Cara (ln 170-171)]
1.1.4.2.2. Not as expected	A comment referring to an interaction which is different to what the user expected, excludes comments referring to navigation	• If I click back, I expect to be in the same page, so the fact that that back button is there is confusing, the fact that it tries to close the tab [Beth (ln 388-390)] • Okay, I guess I think I thought that I was going to actually start setting goals, like right away [Cara (ln 232-233)]
1.1.4.3. Suggestions	A comment that suggests an improvement to the usability of the system	• A suggestion – could we not have links here, rather than a next? [Mike (ln 294-295)] • So, again, I think I would naturally think that the text here is a link, but I think it's fine, if you ... Maybe it could be a link as well, I don't know [Cara (ln 204-206)]

Code Label	Description	Example Quote
1.1.4.4. Navigation	Comments referring to the user's position in the system or navigating around the system	
1.1.4.4.1. Confusing navigation	Comments referring to confusion about where the user is, where the system might take them or whether they have been to that location before. This includes comments referring to whether they have seen the entire system but excludes comments specifically referring to tabs or locked sections	
1.1.4.4.1.1. *Where am I going to end up?*	A comment referring to where the user is heading or where they may end up when following that particular link	• If I want to go through ... choose to finish the quiz rather than click on them – if I go to my homepage, will I still be able to find them? [Beth (ln 238-240)] • You perhaps couldn't work out if you needed to go back, or I wasn't sure, if I clicked on something, it would take me out of the quiz, and things like that [Cara (ln 495-497)]
1.1.4.4.1.2. *Where am I?*	A comment querying where they are in the system or whether they are in the correct place	• I'm wondering if I'm in the right place [Mike (ln 171-172)] • I think I'm thinking I'm a bit confused, whether did I just go into my progress. I'm going to click it again [Cara (ln 311-312)]
1.1.4.4.1.3. *Have I seen this before?*	A comment asking whether they have seen this page or content before, including comments that recognise they have already seen something	• Have I done this? I have ... oh, I have done this, haven't i? I've been on this. So that's ... Yes, I've done this [Mike (ln 467-468)] • I've already done that one [quiz] [Zoe (ln 161)]
1.1.4.4.1.4. *Have I finished?*	A comment asking or stating that the user has seen the entire website	• Is there anything that I've not looked at? [Beth (ln 642)] • I think I'm done [Zoe (ln 258)]

Code Label	Description	Example Quote
1.1.4.4.1.5. *Other*	A comment relating to confusing navigation that does not fit under the other codes	• How do I go back? [Beth (ln 255)] • Okay, that's a different page [John (ln 208)]
1.1.4.4.2. Use of tabs	A comment referring to the use of tabs either initiated by the user or the system	• I'll close [the tab] myself [Beth (ln 392)] • I usually like to open several tabs on websites, so that seems to have worked okay [John (ln 183-184)]
1.1.4.4.3. Locked sections	A comment referring to the locked sections of the website, including a comment that notices something is unavailable	• Is that part of the system that they've built in, that as you progress through the system, more things become available to you? [Mike (ln 420-421)] • Okay, so I need to wait a week before I come back here, I think [Cara (ln 314)]
1.1.4.4.4. Suggestions	A suggestion referring to a different way to navigate or missing navigation, which is required	• So now I need to go back again, even though I've looked at all three questions, so I'd probably want a next button, so yes [Mike (ln 421-423)] • I think that there's a lot of different avenues – there's quite a complex tree and path to follow, so I don't know if that might be better summarised with, maybe, I don't know, more things on the homepage, or a maximum of, sort of, one or two levels of detail from the homepage [Zoe (ln 492-495)]
1.1.4.4.5. Other	A comment that does not fit under the other labels within navigation	• [The intervention is saying] this one thing here which I'm showing you is important. This is what you should look at [Beth (ln 250-251)] • How do I go back? [Cara (ln 255)]

Code Label	Description	Example Quote
1.1.5. Functionality	General comments about the functionality provided by the intervention	
1.1.5.1. Quiz	An opinion or comment relating to the quiz, excluding any comments referring to content	• Quiz was very basic [Beth (ln 683)] • [Quiz] Yes, it was quite good [Zoe (ln 146)]
1.1.5.2. Notifications	General comments about notifications and specifically the intervention notifications, includes suggestions for additional notifications methods	
1.1.5.2.1. That's good	A positive comment referring to the email functionality, excluding comments about content on the 'My Messages' pages	• Getting active messages – that's good [Mike (ln 277)] • I was just thinking, I quite like that, getting messages and stuff. I suppose it's a motivator [Zoe (ln 150-151)]
1.1.5.2.2. Volume or frequency of emails	A comment referring to the number of emails the user already receives or referring to their settings in the intervention	• I have far too many emails in my daily life. I don't want more emails [Mike (ln 279-280)] • I would tend to go for the fewest one, just as a reaction to the amount of emails I get in general [John (ln 233-234)]
1.1.5.2.3. Other	Any other comment referring to the notifications from the system or suggestions, including any comments about the content of the emails	• If you can get me onto some Facebook or social media type of thing, and then send me links to stuff on that, I'm more likely to involve myself [Mike (ln 280-282)] • How often would I actually pay attention to [getting active emails]? [Beth (ln 263-264)]
1.1.5.3. Goal setting	General comments relating to the goal setting function in the intervention	

Code Label	Description	Example Quote
1.1.5.3.1. I like that	A positive comment relating to the goal setting function of the intervention	• You can choose a different activity – that's good. I like the guidance of what I can do but also having different activities to choose from if I want. That's nice because it makes it very person [Mike (ln 483-486)] • I think three's a good number, though, for a week, because you don't want to overdo it [Zoe (ln 200-201)]
1.1.5.3.2. Guidance	A comment referring to confusion about setting a goal, which goal to set, what is a realistic goal, or whether the system will guide the user through the process	• You're still left going, well, I don't know, how many days a week do I want to be doing this activity? What's a realistic goal to set? You're still left with those questions [Beth (ln 667-669)]
1.1.5.3.3. Granularity	A comment referring to the level of detail/granularity of the goals set within the intervention, including whether these meet requirements	• This isn't detailed enough for me, because I could say I just want to do something physical for three days. It won't happen. So I'd need a bit more ... to encourage me to actually choose something that was named [Mike (ln 510-513)] • The intervention] makes you be very specific and set those short term goals [Beth (ln 736)]

Code Label	Description	Example Quote
1.1.5.3.4. Goal options	A comment about the pre-set options available in the goal setting section of the intervention	• So I'm thinking that the activity I want to do is not on here, so I'm going to do running in the mornings. Running. To write your own goal [Cara (ln 285-286)] • [T]here doesn't seem to be one regarding outdoor exercise, or sports in general [John (ln 317-318)]
1.1.5.3.5. Printing	A comment about the printing feature within the intervention	• I'd want an option to text it to me, email it to me. We shouldn't be encouraging people to print [Mike (ln 524-525)] • Okay, I could stick that up in my office, and it would be set in stone [Cara (ln 299)]
1.1.5.3.6. Other	Any other comment that does not fit under the other labels	• I guess I'm wondering if, in a week, I'll get some kind of reminder to tell me to enter how well I did, because I'm thinking I probably will forget, and especially if I didn't go running, I'm unlikely to come back on here and admit it [Beth (ln 305-308)] • [T]here are four options there, but I seem to remember there were six, six items on the previous information page. I don't know if that's supposed to correspond exactly [John (ln 314-316)]
1.1.5.4. Additional features	Comments about the additional features offered within the intervention	

Code Label	Description	Example Quote
1.1.5.4.1. Pedometer	A comment referring to the free pedometer offered within the interventions	• I still don't know if it's free. I'm concerned that I don't know it's free [Mike (ln 363)] • I like that, you can get a step counter. That's good [Zoe (ln 222)]
1.1.6. Support	Comments referring to support required or provided by the intervention, excludes comments referring to support for illness management or carrying out the desired activity	
1.1.6.1. FAQs	Any comment about the FAQs section of the intervention including how the individual uses this section, excludes specific comments about content	• I don't look at frequently asked questions, so I'm not going to look at it [Mike (ln 176-177)] • [FAQs are] more likely to answer my question, rather than me trailing all the way through the website, so that was quite detailed [Zoe (ln 303-304)]
1.1.6.2. Intervention designers	Any comment about the intervention designers, including comments about the desire to contact them	• How do I contact you if I want to? I can't see a contact. I might want to contact you [Mike (ln 453-455)] • I want to be able to do more. I want to be able to talk to someone, or just get more information from it at a later stage, as you progress [Beth (ln 671-673)]
1.1.6.3. Other users (Forum)	A comment referring to the desire to talk to other users, for example through a forum	• Actually get users to help other users [Mike (ln 603)] • My support bit, if there was – I don't know – a forum, a forum page on there for people who are using the site, if they've got questions [Beth (ln 697-699)]

Code Label	Description	Example Quote
1.1.6.4. Other	Any other comment referring to support and the intervention	• I'd want you to have a Facebook page and a Twitter [Mike (ln 418)]
1.2. Expectations	Comments relating to an expectation – either from before or during use – of the intervention	
1.2.1. As expected	A comment referring to a met expectation of the intervention	• [I]t's quite clean and clear, quite modern. It's what I would expect to see of a website these days [John (ln 167-168)] • I think [the intervention] was sort of what I expected [Zoe (ln 308)]
1.2.2. Not as expected	Comments relating to an expectation – either from before or during use – that was not met by the intervention	
1.2.2.1. Content	A comment relating to an unmet expectation of the content within the intervention	• That hasn't given me as much detail as I thought it was going to [Mike (ln 248-249)] • Again, this is the kind of stuff that I expected from the 'my progress' link [Beth (ln 592)]
1.2.2.2. Usability	A comment relating to an unmet expectation of intervention usability, including comments about navigation	• If I select an activity, I would've expected that to automatically select, so I suppose this is the same, is it? [Mike (ln 488-489)] • You'd click on it, and then I'd think that I was going to go straight and get stuck in, and then it would be another page with more information [Cara (ln 474-476)]

Code Label	Description	Example Quote
1.2.2.3. Other	A comment relating to an unmet expectation which does not fit under the other themes	• There aren't as many things to click on as I would expect, not quite so many options available but perhaps that's not a bad thing [Beth (ln 244-246)] • I would have [the tabs] on the left, but that's just me, because that's where I always look [Zoe (ln 295-296)]
1.3. Usage	Comments referring to any type of usage of the intervention, including changes in usage, aspects that encourage usage and locations of usage	
1.3.1. Change (in use) over time	A comment referring to a change in usage over time, either within a session or over multiple sessions	• I didn't want to look at the FAQs earlier; now I'm a bit more interested [Mike (ln 438-439)] • If I was doing this at home, I probably wouldn't have got this far. I probably would've stopped and gone, well, if you're not going to help me, I'm just going to leave [Beth (ln 472-474)]
1.3.2. 'Give it a go'	A comment referring to whether the individual would use the intervention in the real-world	• [If GP asked you to use it] I'd probably have a look at it [Beth (ln 727)] • [If GP asked you to use it] I think I would say almost certainly that I would, but it's just whether I actually would [Cara (ln 543-544)]

Code Label	Description	Example Quote
1.4. Barriers to usage	Any comment relating to a barrier that prevented usage of the intervention	• I just think my main, kind of, worry would be that there's lots of stuff like this out there, and how you would get people to use your service [Cara (ln 438-440)] • [Safety of Getting Active] I'm going to skip through these, because I don't have these conditions [John (ln 456)]
1.4.1. Overcoming barriers	A comment referring to a barrier to DBCI usage that the individual has overcome	• So, yes, if you're wanting me to keep coming back, I suppose it's just about that continual encouragement [Mike (ln 540-541)] • I quite like websites where font is quite simple to read and you can scan it quite quickly [Melissa (ln 241-242)]
1.5. Emotions	A comment which shows an emotional reaction to the intervention or interactions with the intervention	
1.5.1. Frustration	A comment that shows the individual is frustrated or irritated by the intervention, excluding comments relating to usability	• There's nothing here that tells me anything, it's just a link page, unnecessary [Mike (ln 275)] • Being active is good for my overall health. Well, obviously [Beth (ln 237)]
1.5.2. Worry	A comment that shows the individual is worried by the intervention	• I'm not surprised by that [fact that exercise improves symptoms], but it definitely is still a worry [Beth (ln 211-212)] • I guess this has kind of made me worry about safety [Cara (ln 330)]

Code Label	Description	Example Quote
1.5.3. Confusion	A comment that explicitly states that the individual is confused by the intervention	• I've never seen [content locked] before on a website. It confuses me [Beth (ln 437)] • I think I'm thinking I'm a bit confused, whether did I just go into my progress. I'm going to click it again [Cara (ln 311-312)]
1.5.4. Happy/Calming	A comment showing a positive emotional response such as amusement or calming	• But that's amusing [answer to question 4 on the quiz] [Mike (ln 220-221)] • These little graphics are very funny [Beth (ln 568)]
1.5.5. Other	Any other comment referring to an emotional response to the intervention	• I'm a bit bored now [how can getting active help me] [Mike (ln 274)] • It suggests that there are some activities out there that're very dangerous, and are going to cause you harm, and that you shouldn't be doing them' it's all very negative [Beth (ln 187 – 189)]
1.6. Overall impressions	A comment referring to the user's overall impression of the intervention	• [The intervention is] kind of very plain and simple, and lots of white, not overly graphic-y. [The intervention] looks kind of professional in that sense [Beth (ln 182-183)] • Yes, it's nice [Zoe (ln 287)]

Code Label	Description	Example Quote
2. Target audience	A comment about who the user thinks the target audience is, should be or the appropriateness of the intervention for different users	• I think, if you were newly diagnosed with asthma, if would be really good [Mike (ln 610)] • I can only speak for myself, but I don't know if maybe younger children would have the same kind of experience that I had with navigating the website, or if they would find it harder or easier [John (ln 517-519)]
2.1. Newly diagnosed	A comment referring to the appropriateness of the DBCI for individuals that are newly diagnosed	• [Quiz[I know quite a bit about asthma because I'm a student nurse myself, but for people that were newly diagnosed, I suppose it would help them [Zoe (ln 148-149)] • [would you recommend it?] Probably people that are newer to asthma [Melissa (ln 278)]
2.2. Not very active	A comment referring to the appropriateness of the DBCI for individuals that are not very active	• I think this might work better for people who are just getting into this getting active thing, which I guess, where you're aiming for [Cara (ln 447-448)] • [Recommend to others?] Yes. Yes, especially if they were saying to me that they can't do things because they've got asthma, or anything. I'd say 'maybe you should go and have a read' [Zoe (ln 326-327)]

Code Label	Description	Example Quote
2.3. Older users		A comment referring to the appropriateness of the DBCI for individuals that are 'older' • [P]robably older people, probably just kind of starting to get into it, yes, who need to get more active, probably [Cara (ln 531-532)]
2.4. Younger users	A comment referring to the appropriateness of the DBCI for individuals that are younger or young	• Young people would find it fine to use [Mike (ln 624)] • I can only speak for myself, but I don't know if maybe younger children would have the same kind of experience that I had with navigating the website, or if they would find it harder or easier [John (ln 517-519)]
2.5. Other	A comment referring to the target audience that does not fit into the other categories	• For people who don't want to interact with anyone else, they can still get all the information passively, and that's really useful, not being forced into having to have a conversation with someone else [Beth (ln 708-711)] • [Can a step counter help me get active?] I think [the free pedometer] will appeal to quite a lot of people and it's quite a fun idea to keep track of how many steps you're taking [Melissa (ln 102-103)]

Code Label	Description	Example Quote
3. Related apps & websites	A comment about a similar app or website, including any comparisons, evaluations of other sites and products they already use	• I looked at the NHS Choices website, just to get more information and understanding about it [Beth (ln 124-125)] • And, like I said about the step counter, that's always a good thing to have, because it's something that you can just look at, rather than having to go through your phone and find the app [Zoe (ln 317-319)]

Table F.5: Getting Active (Stage 1): 'Illness' DisENGAGE Codebook

Code Label	Description	Example Quote
1. History of illness	A comment referring to the individual's history of the illness, when they were diagnosed or recalling childhood memories	• I've grown up with it, had it my whole life [Mike (ln 15)] • Diagnosed [at] 18 months [Cara (ln 16)]
2. Triggers for illness	Comments that refer to the triggers for that individual's illness	
2.1. Environment	A comment referring to an environmental trigger for their illness, excludes animals	• I get concerned that the environment outside is going to trigger the symptoms [Beth (ln 100-101)] • [R]ecently, it's dropped quite cold, so I'm using the inhalers a bit more often [Zoe (ln 5-6)]
2.2. Animals	A comment referring to animals triggering symptoms	• Whenever I went near animals with fur, I'd get wheezy [Beth (ln 20-21)]
2.3. Emotions	A comment referring to symptoms being triggered by an emotional reaction	• My asthma gets worse if I'm stressed, so again, I suppose that's the emotion, so if I get upset or stressed about something [Mike (ln 77-79)] • I got so excited that it triggered an asthma attack [John (ln 18-19)]
2.4. Exercise	A comment referring to exercise triggering symptoms	• I know that [my asthma] will limit some activities [Beth (ln 16)] • I normally get a tight chest or symptoms after I've done the sport [Cara (ln 35-36)]
3. Self-management	Comments referring to how the individual personally deals with their illness, including attempts to manage it, and failed attempts of management	

Code Label	Description	Example Quote
3.1. Knowledge	Comments relating to the individual's current knowledge about their illness or their approach to knowledge	
3.1.1. Seeking additional advice	A comment referring to whether the user has sought out additional information about their illness	• Never looked on the Internet for advice about living with asthma [Mike (ln 118)] • I looked at the NHS Choices website, just to get more information and understanding about it [Beth (ln 124-125)]
3.1.2. Knowledge behaviour gap	A comment that highlights the gap between their knowledge and behaviour (an inconsistency in behaviour)	• [The NHS Choices website] just told me that I have no excuse for not taking my medication, and I need to take it. Knowing that information still doesn't change my behaviour [Beth (ln 138-139)] • [The doctor] just suggested I should just take care of myself a bit more [Cara (ln 9-10)]
3.1.3. I know that	A comment referring to knowledge (about their illness) that the user already had – i.e. how knowledgeable they are about their illness	• I know that people with asthma have benefitted from physical activity, so I'm not really interested [Mike (ln 229-230)] • I know that information already, that activity is okay [John (ln 181)]
3.1.4. Other	Any other comment about knowledge relating to the illness	• Again, I did know that, really. I've just never thought of it [Mike (ln 246-247)] • I probably do know what they are, but I'd like to be reminded of that [Mike (ln 254-255)]

Code Label	Description	Example Quote
3.2. Self-care	Comments about how the individual actively manages their illness, including how controlled it is and their medication helps achieve this, excludes emotions and feelings about their illness but includes comments about their general health	
3.2.1. General health	A comment about the individual's general health	• [The doctor] just suggested I should just take care of myself a bit more [Cara (ln 9-10)] • I think my problem is not just looking after myself in that sense [Cara (ln 97-98)]
3.2.2. Non-adherence to medication	Comments about their non-adherence to medication, either through active or passive means	
3.2.2.1. Active non-adherence	A comment referring to an active choice to not adhere to medication	• I was mainly looking [at the NHS website] as a way to justify not taking my medication [Beth (ln 125-126)] • [GPs] actually given me a prescription for a spacer, but I'm very naughty, and haven't actually gone and picked it up yet, because I'm busy [Cara (ln 95-97)]
3.2.2.2. Remembering	A comment referring to whether the user remembers to take their medication when they should	• I have a really bad memory, and I'm really, really rubbish at sticking to a routine, so I get told off for not taking it twice a day as I should [Beth (ln 107-108)] • I just kind of have to make sure that I take my inhalers everywhere, and remember to take my steroid inhaler in the morning [Cara (ln 2-4)]

Code Label	Description	Example Quote
3.2.3. Level of 'control'	A comment relating to the level of control the individual feels in regard to their illness	• I hadn't been controlling my asthma so I went to the GP because I was struggling [Mike (ln 99-101)] • Every year I get told off [by the nurses] that I'm not controlling my asthma [Beth (ln 106)]
3.2.4. Techniques for controlling asthma	A comment referring to a method they use for controlling their asthma	
3.2.4.1. Controlling with exercise	A comment referring to their use of exercise to control their illness	• [Anything else help with asthma] I guess maybe I just try and keep quite fit [Cara (ln 86)] • Staying healthy and fit is its own medicine in a way [John (ln 70)]
3.2.4.2. Pharmacological interventions	A comment referring to the support offered by a pharmacological intervention such as an inhaler or antihistamine	
3.2.4.2.1. Inhalers	A comment referring to the use of an inhaler as a means of support to the individual	• I know that I've always got my inhaler, so I suppose that helps me feel confident to do what I want to do [Mike (ln 47-48)] • I do use it daily, sometimes probably without realising, you know, because it's almost like an automatic process [John (ln 3-4)]
3.2.4.2.2. Antihistamine	A comment referring to the use of an antihistamine as a means of support to the individual	• As long as I've remembered to take an antihistamine [...] I know that'll reduce the likelihood I'll need to use an inhaler [Beth (ln 59-63)]
3.3. Support	Comments referring to the support that the individual receives to handle their illness	

Code Label	Description	Example Quote
3.3.1. Healthcare professional	Any mention of interactions with a doctor, nurse or pharmacist	• Every year I get told off [by the nurses] that I'm not controlling my asthma [Beth (ln 106)] • So, I do attend the asthma appointments, and listen to what they say [John (ln 97)]
3.3.2. Family & friends	A comment referring to how family members or friends engage with the individual's illness	• My other half worries about [my asthma] more than I do [Beth (ln 2-3)] • I guess my boyfriend will nag me, and ask me if I've taken [my inhaler], as will my mother [Cara (ln 107)]
4. Emotions & feelings	A comment relating to the relationship between emotions and their illness	
4.1. Emotional reaction to illness	A comment referring to an emotional reaction to a symptom or illness episode	• Emotional asthma [Mike (ln 24-25)]
4.1.1. Worry	A comment referring to a sense of 'worry' regarding their illness	• Having an asthma attack is worrying and scary, feels like I can't breathe [Mike (ln 4-5)]
4.1.2. Fear/panic	A comment referring to a sense of 'fear' or 'panic' regarding their illness	• But [the swimming pool asthma attack] was quite scary being on my own in water, having an attack, so I've been really put off going swimming [Beth (ln 41-42)] • I was in complete panic mode. I didn't feel settled [Zoe (ln 43-44)]
4.1.3. Stress	A comment referring to a sense of 'stress' linked to their illness	• I'll get short of breath, and yes, then the asthma will make me even more stressed [Mike (ln 79-80)] • New York was quite stressful, because I was quite ill [Cara (ln 72)]

Code Label	Description	Example Quote
4.1.4. Other	A comment relating to an emotional reaction to illness that does not fit in the other categories	• Walking to work can get out of breath which can be frustrating [Mike (ln 10-11)] • Emotional asthma [Mike (ln 24-25)]
4.2. Feelings about illness	A comment referring to their feelings or attitude towards having the illness, excluding specific emotional reactions	• That might just be my own perceptions that my asthma isn't actually that big of a deal [Beth (ln 190-191)] • So, yes, I do remember feeling a bit debilitated [John (ln 22-23)]
4.3. Reactions to pharmacological support	A comment referring to an emotional reaction or attitude towards the use of or reliance on a pharmacological intervention	
4.3.1. Emotional reaction	A comment referring to an emotional reaction to a pharmacological intervention, including the absence of the medication	• On the occasions where I've forgotten [the inhaler], it's caused me to panic [Mike (ln 46-47)] • I've not had my Ventolin on me, or for whatever reason, it's not working as well as it should [...] Yes, that's quite annoying, and a bit worrying sometimes [John (ln 56-61)]
4.3.2. Attitude towards	A comment referring to the individual's attitude towards their pharmacological intervention	• So, it wouldn't stop me doing things, because I know that I've got my inhaler [Mike (ln 59-60)] • I haven't got any stigma about taking my inhaler [John (ln 43)]

Table F.6: Getting Active (Stage 1): 'Activity' DisENGAGE Codebook

Code Label	Description	Example Quote
1. Knowledge	A comment referring to their knowledge of activity and its relationship with the illness	• Exercising and getting my fitness improved really improved my asthma [Beth (ln 94)] • More, perhaps not, no, but I'm encouraged that the activity that I am doing is in line with that advice [John (ln 558-559)]
2. Current activity	A comment referring to the individual's current activity level	• I'm doing a lot of walking at the moment [Mike (ln 482-483)] • I try and get to the gym three or four times a week [Zoe (ln 353)]
3. Barriers to activity	Comments referring to barriers the individual faces when trying to be active	
3.1. Illness	An activity barrier linked to the individual's illness	
3.1.1. Symptoms	A comment referring to a flare up of symptoms which prevent activity, excluding environmental factors	• Walking to work can get out of breath which can be frustrating [Mike (ln 10-11)] • [T]he only time I really think about having asthma is when I'm about to do some cycling or running, and when I want to ... [John (ln 4-6)]
3.1.2. Environment	A comment referring to the environment triggering their illness, and this preventing activity	• If the weather is very hot or very cold, I won't go on my bike because of my asthma [Beth (ln 7-8)] • I wouldn't have been able to walk up the stairs in the winter. It'd have been really bad [Zoe (ln 24-25)]

Code Label	Description	Example Quote
3.1.3. Emotion	A comment highlighting an emotional reaction to the effect their illness has on being active	• I'm not surprised by that [fact that exercise improves symptoms], but [exercise is] definitely is still a worry [Beth (ln 211-212)] • [Prevents activity] it's just the stress and the worry behind [tight chests and inhaler not working], I guess. So that would impede me from going [Zoe (ln 360-361)]
3.2. Inconvenience (Time & Cost)	A comment regarding the inconvenience, either time or cost, of being active	• The reason I don't do it is because of the time, not because I need more encouragement. It's because I haven't got the time [Mike (ln 635-637)] • [New activities will] cost money, more than likely, and that would be a massive barrier [Beth (ln 384-385)]
3.3. Lack of desire	A comment highlighting a lack of desire or want to be more active, including an apathy towards being active	• My own mentality gets in my way, for sure. Both me and my other half, we say we want to get more active, but then we just get home and we sit on the sofa, and the X Box is far more interesting than going out for a walk. So, I think your own mentality is the biggest barrier to doing things [Beth (ln 743-746)] • No, other than maybe the seasons, so obviously in winter, it's dark and wet, and it's not really the time that you would want to try to start an activity [John (ln 568-569)]

Code Label	Description	Example Quote
3.4. Lack of support	A comment referring to the lack of support to be active	• If my partner was interested in the same activities as I was, that would be good ... She doesn't play, so that makes it difficult [Mike (ln 651-654)] • Me and my other half, we always say that we both need to get more active, and we both need to do stuff, and we just never do it [Beth (ln 364-366)]
3.5. Other	Any other comment referring to barriers that prevent the individual being active	• I'd always like to do more. That's always my perpetual goal, is to do more, but that's very broad [Beth (ln 735-736)] • [W]hen you have a period of inactivity, it's difficult to get back into it [John (ln 563-564)]
4. Overcoming barriers to activity	A comment referring to tools or techniques that help the individual overcome barriers to activity	
4.1. Inhaler	A comment highlighting the individual's use of an inhaler to enable their activity	• Uses inhaler before activity [Mike (ln 21-22)] • I don't stop doing any of these things – I just make sure I have my inhaler when I'm there [Cara (ln 86-87)]
4.2. Support	A comment referring to how the individual's support network helps them overcome their barriers to activity	• [getting friends and family involved] really helpful [Beth (ln 579-580)] • I guess, and it encouraged you to join support networks sites and social networks sites, so something like that, I guess, but that sort of points you in that direction. So, I guess that would encourage me, I guess [Zoe (ln 363-366)]

Code Label	Description	Example Quote
4.3. Routine	A comment explaining how a routine or calendar helps to overcome barriers to activity	• [Addressing the time issue regarding activity] if you have something, kind of, in your calendar, or you've agreed to do it with someone else and they're expecting you to turn up, then [Cara (ln 566-568)] • I've brought my bike over in my car, and now I cycle that couple of miles every day. It's not much [John (ln 597-598)]
4.4. Other	Any other comment explaining ways the individual overcomes barriers to activity	• It doesn't stop me doing things, but only because I get over the fact that I'm worried [Mike (ln 192-193)] • I have to be doing something – I can't just go for a ride, so doing something like DIY work around the house, it's a means to an end and I can do that far more than just doing dedicated exercise, so this is good [Beth (ln 379-382)]

Table F.7: Getting Active (Stage 2): 'Individual' DisENGAGE Codebook

Code Label	Description	Example Quote
1. Personality characteristics	A reference to the individual's personality, character, or nature	• I'm a bit of a sloth really when it comes to things like that [Grace (ln 45-46)] • Because I got too lazy [Amelia (ln 160)]
2. Demographics	Any comment relating to an individual's demographics	• I'm a science student [Faye (ln 398)] • I'm Italian [Eva (ln 51)]

Code Label	Description	Example Quote
3. Skills & Attitudes	Comments relating to an individual's ability or skill set	
3.1. Technical	A reference to an individual's technical knowledge or skill	• Well, being a bit of a technophobe [Maggie (ln 170)] • Not challenging, frustrating I think [...] And if it doesn't happen quickly enough I then have to wait until I'm in a zone where if I actually do end up contacting somebody it's going to be a pleasant conversation because otherwise I won't [Grace (ln 141-146)]
3.2. Other	Any other comments relating to an individual's ability or skill set	• [Reading English particularly difficult?] It's a bit difficult for me still [Eva (ln 60)]
4. Internet Use	A comment relating to the individual's usage of the Internet	• [How often?] Numerous times each day and for work, social networking, entertainment, shopping [Jacobe (ln 3-4)] • Every day for everything from research to communication [Christoph (ln 3)]

Table F.8: Getting Active (Stage 2): 'Intervention' DisENGAGE Codebook

Code Label	Description	Example Quote
1. Usage	Comments referring to any type of usage of the intervention, including changes in usage, aspects that encourage usage and locations of usage	
1.1. Context	Comments referring to any a specific usage session, including the device that was used, the time and location, the number of sessions, or what prompted the session	
1.1.1. Device	A comment relating to the types of devices the individual used when accessing the intervention, including the browser	• My laptop [Faye (ln 3)] • Chrome [Lena (ln 31)]
1.1.2. Location & time	A comment relating to the time or location when the individual accessed the intervention	• So when I come home from work mainly. Yeah, so later in the evening 5 o'clock-ish. It's mainly my phone because it's easier to access it, via that [Fraser (ln 29-30)] • Usually at home [Grace (ln 73)]
1.1.3. Frequency/Number of log ins	A comment relating to the number or frequency of times that the individual logged into the intervention	• I've definitely logged on three for the setting the goals, and maybe another couple of times in between, so maybe five I've probably logged on [Katie (ln 401-403)] • [You say you used it twice?] Yeah, two or three times [James (ln 446)]

Code Label	Description	Example Quote
1.1.4. Usage prompts	A comment relating to something that led to the individual logging into the intervention	• [I]t would either be in response to one of the email notifications or just when I suddenly remembered about it [Jacobe (ln 30-32)] • So normally when I would get emails saying ... reminding me to update my goals I would then go in and say how I did on my goals for that week, and set my goals for the next week [Lena (ln 33-35)]
1.2. Barriers to usage	Any comment relating to a barrier that prevented usage of the intervention	• Maybe because it's all the same colour it makes you kind of feel like ooh, I'm not going to look at all the little words [Becky (ln 295-296)] • [Any reason you didn't explore some of the content?] I think because I had three deadlines to meet on my course, and my grandchildren here [Grace (ln 106-107)]
1.3. Change (in use) over time	A comment relating to the change in usage of the intervention over a period of time, excluding plans for future use	• So the first time would be the longest, so setting everything up and I was reading through everything, and then since then I've been on it twice more, for probably about maybe five or ten minutes a time [Becky (ln 204-206)] • But I got a bit muddled at the beginning; I think I'm okay with the website now, so I can zip around and find the bit I want [Maggie (ln 109-110)]

Code Label	Description	Example Quote
1.4. Future use	A comment relating to future usage of the intervention, both positive and negative comments	• I think really to go in and just up the ante. I'd really need to go in and think, okay, you know, to use this really well what ... and to stop sort of farting around with 15 minutes a day, what could I do to really ... I think seeing as winter's coming particularly I would have to do that, yeah [Grace (ln 592-595)] • I'd probably not unless it gained a little more functionality, so whether you could like with somewhere to put your steps in, or, you know, reminders about your badminton, or linking with friends on it, something like that, probably not [Katie (ln 458-461)]
1.5. Outcomes	Comments referring to any outcome that has resulted from the use of the intervention, including digital and behavioural outcomes	
1.5.1. Motivational/Point of focus	A comment relating to the DBCI either motivating the individual or providing a point of focus for their behaviour change attempt, excluding comments relating to activity or behavioural lifestyle changes	• I think I'm a bit more conscious of what I'm doing during the day [Fraser (ln 128)] • It's ... so it's brought it to my attention again; it's served that ... that's been a good purpose, it's focused me [Mia (ln 332-333)]

Code Label	Description	Example Quote
1.5.2. Activity/Lifestyle changes	A comment relating to activity or behavioural lifestyle changes as a result of DBCI usage	• I mean in terms of running and everything else I was doing it's not really changed, but I've ... I think the main change I've made recently is walking more [Lena (ln 358-360)] • I've been running more since I've been using it [James (ln 361)]
1.5.3. Other	Any other comment relating to an outcome from the DBCI usage	• [T]his sort of website helps me feel better about myself, you know I'm not, there's other people have, are exactly the same [Maggie (ln 393-395)] • I've lost five pounds in probably about four weeks [Grace (ln 221)]
1.6. Other	Any other comment relating to usage that does not fit under one of the other labels	• And it was quite useful just to pop on and have a little look [Becky (ln 243)] • I'm one of those people that presses the button about 10 times really fast, if I don't get on it fast, and it doesn't work out fast, then ... but once I'd got onto it, it was fine, and I understood it [Mia (ln 63-65)]
2. User experience (UX)	Comments relating to a user's experience or interaction with technology, including comments relating to the intervention	
2.1. Expectations/Perceptions	Comments referring to an individual's expectation or perception of the the DBCI	

Code Label	Description	Example Quote
2.1.1. Expectations	A comment referring to an individual's expectation of the DBCI, including prior to use and during use	• I assumed there would be quite a lot of information about asthma, like, maybe tips and approaches to managing it a bit. And maybe like particular types of exercise or something that would be good or advised. Maybe just as a warm- up type thing to sort of manage the condition [Jacobe (ln 21-24)] • [Quiz] And I also would have expected maybe some more health and safety tip stuff instead of that, so instead of ... obviously I get it's important to say it's safe to do this, that, and the other, but maybe it would have been better to say is it sensible to take your inhaler [Lena (ln 223-226)]
2.1.2. First impressions	A comment referring to an individual's first impression of the intervention	• I thought it was a very good concept and idea to begin with [Becky (ln 67)] • But I got a bit muddled at the beginning; I think I'm okay with the website now, so I can zip around and find the bit I want [Maggie (ln 109-110)]

Code Label	Description	Example Quote
2.1.3. Main purpose	A comment referring to what the individual thought the main purpose of the DBCI was	• [Main purpose?] I think to get people active and it's kind of...because when you've got asthma it's kind of scary in case you're going to have an attack when you exercise. So it's kind of getting people out of that misconception of when you exercise you're going to have an asthma attack. It's a bit of support as well, that kind of thing [Fraser (ln 18-22)] • Well pretty much what it says on the tin. I don't think it does it particularly well but I think that's what it's trying to do [Amelia (ln 26-27)]
2.1.4. Overall judgement	A comment referring about the individual's overall judgement of the intervention, their lasting impression	
2.1.4.1. Positive	A positive comment referring to an individual's overall judgement of the intervention, excluding comments about the DBCI's future potential	• I think, no, no I think everything was quite useful [Becky (ln 247)] • This website is ideal, because you can get all the information you need [Maggie (ln 43-44)]
2.1.4.2. Negative	A negative comment referring to an individual's overall judgement of the intervention, excluding comments about the DBCI's future potential	• It's a little simplistic [Faye (ln 301)] • [Overview of Getting Active] I said it didn't quite do ... it attempted to do what I thought it would, but not in the way I thought it should have [Amelia (ln 52-54)]

Code Label	Description	Example Quote
2.1.4.3. Other	A comment relating to a judgement about the intervention that is neither positive nor negative, including judgements about the future potential of the DBCI	• But I think it could, it could be exciting [ln 645] • So aesthetically it seemed like relatively simple and like everything was, I don't know, quite big, and images and buttons and things like that were obviously quite ... like quite accessible and quite like obvious what you had to do. I guess it was ... and like the level of information coming through felt quite simple, like it definitely wasn't trying to like hit me over the head with research about asthma, there was like quite simple messages, quite straightforward like statements and sort of pieces of information that were like trying to motivate me, or like teach me about ... teach me about something to do with activity [James (ln 56-64)]
2.2. Intervention features	Comments relating to the user interface, interactions with the system, feelings about the intervention or usage, usage, and expectations	
2.2.1. Aesthetics	Any comments relating to the look of the interface, including graphics, colour schemes and layout	
2.2.1.1. Positive	Positive comments relating to the look of the intervention	
2.2.1.1.1. Use of graphics	A positive comment regarding the images or photos used within the intervention	• Oh, the pictures are cool, I like the pictures [Lena (ln 320)] • Yeah, they're just nice little fellows hanging around on the site, that's cool [Amelia (ln 338-339)]

Code Label	Description	Example Quote
2.2.1.1.2. Colour scheme	A positive comment relating to the colour scheme of the intervention	• Yes. The colour scheme was good [Eva (ln 129)] • Okay. The white was quite appealing, it was quite clean and crisp. Was it teal? Whatever colour that was on it. But yeah it made pop out on the screen a bit. So yeah, I can't think of anything that could improve that way [Fraser (ln 112-114)]
2.2.1.1.3. Other	A positive comment referring to the aesthetics of the intervention, excluding the use of graphics and colour	• It's clear in what it's presenting and things like that, it makes it obvious, like what you need to click on or do to get somewhere [Jacobe (ln 166-167)] • Yeah, like font's nice [James (ln 301)]
2.2.1.2. Negative	Negative comments relating to the look of the intervention	
2.2.1.2.1. Use of graphics	A negative comment regarding the use of graphics within the intervention	• I don't know, something, just like an active little, an active figure or something that looks like it's really you know, having fun, or you know engaging [Becky (ln 145-146)] • [Pictures?] You see I'm in education so I see so many of those things, so I just think oh yeah, right, and move on [Grace (ln 441-442)]
2.2.1.2.2. Layout	A negative comment relating to the layout of the user interface, including the location of buttons, tabs and images	• Like, it's not awful but, like a lot of it is very boxy, is how I would describe it [Jacobe (ln 160)] • I mean I guess I would kind of expect the menu bar at the top and to have sort of nice hover overlays [Lena (ln 333-334)]

Code Label	Description	Example Quote
2.2.1.2.3. Font	A negative comment regarding how the look of the text implies it is a link	• I've just got a personal preference against clip art and comic sans [Fraser (ln 108)] • I was quite annoyed by the design of it, because it has all of these different texts and different colours, and usually, you know, when you use the internet regularly that you know ... you learn that different colour text means there's a link, but there isn't. So, I tried clicking everywhere and there was just nothing, and that really pissed me off [Amelia (ln 54-59)]
2.2.1.2.4. Colour scheme	A negative comment relating to the colour scheme of the intervention	• [M]aybe because it's all the same colour it makes you kind of feel like ooh, I'm not going to look at all the little words [Becky (ln 295-296)] • [I]t looks a bit like, a tiny bit like hospital [Faye (ln 278-279)]
2.2.1.2.5. Other	Additional negative comments that do not fit under any of the other labels	• Thinking about it in comparison to like modern websites it has a feel of something that maybe is not so sleek [Jacobe (ln 162-164)] • I don't love it, I mean it's not offensive or anything, you know, it's not horrible, but it feels a bit 1990s [Lena (ln 290-291)]
2.2.1.3. Suggestion	A suggestion about the aesthetics of the intervention	

Code Label	Description	Example Quote
2.2.1.3.1. Colour scheme	A suggestion about the colour scheme of the intervention	• Yeah, it's very slightly boring. I don't like only two colours ... would be nice in a bit more colour [Mia (ln 95-96)] • It could be bright, could have it orange, people would notice that [Christoph (ln 184-185)]
2.2.1.3.2. Other	Any other suggestion about the aesthetics of the intervention	• I think that [getting active with asthma] should be made more prominent actually, thinking about it [Becky (ln 653-654)] • Also using Ajax would probably make it feel a bit more modern because you kind of get used to a lot of websites where you don't have that refreshing push to a new page [Lena (ln 333-336)]
2.2.1.3.3. Other	Any other comment about the aesthetics of the intervention, which does not fit under one of the other labels	• [Colour Scheme] Erm...it's, yeah, it's fine. Yeah, it's, again I have no opinion on it [Jacobe (ln 177)] • [The pictures] I think I remember what they were, and the point is they were not distracting and that's probably what this sort of picture wants to be. So, if I remember them that would probably be a bad thing because I would have looked more at pictures than at actual content. So, yeah, I don't remember them but I don't think that that is bad [Amelia (ln 326-331)]

Code Label	Description	Example Quote
2.2.2. Content	Any comment relating to the text-based content of the intervention, including whether the user knows the information and whether they react positively or negatively to the information provided	
2.2.2.1. Positive	Positive comments relating to the information and text-based content of the site	
2.2.2.1.1. I like that	A comment relating to particular content that the user likes or thinks is good, excludes comments that specifically use the word 'interesting' or relating to novel ideas but including email content	• I liked [the emails]. I thought they were really positive, that they weren't scolding you because you hadn't done it yet, but they were boosting you because you could do it [Faye (ln 227-229)] • I liked that it is a positive message that you can still do whatever you want when you've got asthma [Lena (ln 99-101)]
2.2.2.1.2. Interesting	A comment that uses the word 'interesting' or states that the content is novel or new, excludes general positive comments	• It was quite interesting. I thought you could guess the answers, maybe, or they could be. It was quite interesting again. About misconceptions and things you've heard before but perhaps need reminding of [Fraser (ln 84-86)] • [Success stories] Like they were interesting but I'm not sure I ... I don't feel any deeper emotions about that [James (ln 234-235)]

Code Label	Description	Example Quote
2.2.2.1.3. Motivational	Comments about text-based content that motivates the user to be more active	• I think it's actually got a lot of good, useful information in it, that is really good to know, and is quite encouraging, yeah, so I would [Becky (ln 690-691)] • [Success stories] Yeah, they were quite uplifting, weren't they, and they felt quite real, so that was nice. Whether they were real or not I don't know, but, yeah, it was quite good to feel that, you know, I've done this and I feel better about it [...] So, it's quite nice to have some good stories [Katie (ln 217-224)]
2.2.2.1.4. Other	Additional positive comments that do not fit under any of the other labels	• This website is ideal, because you can get all the information you need [Maggie (ln 43-44)] • I liked the way this one's tailored just for, well more for asthmatics [Faye (ln 378-379)]
2.2.2.2. Negative	Negative comments relating to the text-based content of the intervention	
2.2.2.2.1. I knew it already	Comments relating to the content that an individual already knows	• [What did you learn?] I'm not sure there was anything [Jacobe (ln 48)] • [Quiz] I think I knew quite a few of them. I didn't have to think I think I pressed the right buttons [Eva (ln 97-98)]

Code Label	Description	Example Quote
2.2.2.2.2. Unclear information/wording	A comment about needing clarity, more detail, or confusion regarding the meaning of the text, excludes comments where the individual understands the meaning of the text	• [Messages] I got a bit confused when it said "you can message yourself", but I found out afterwards it's when you've done a week of your goals that you can then put a message on then to say "well done" [Maggie (ln 104-107)] • [My Support] I think My Support was a bit unclear; I wasn't sure what was that [Faye (ln 157)]
2.2.2.2.3. Not targeted enough	A comment about content that is not relatable or relevant to the individual, including comments relating to the lack of tailoring, static nature of the text-based information or lack of asthma-specific content	• Maybe something more about asthma on it would be good [Becky (ln 249-250)] • [Success stories relevant to you?] probably not. Like I don't think ... like I didn't ... yeah, I don't think I was engaged with them enough to say that I was strongly ... like strongly associated with them [James (ln 238-240)]

Code Label	Description	Example Quote
2.2.2.2.4. Other	Additional negative comments that do not fit under any of the other labels	• Then there was that quiz that you answered that referred to a lot of studies, being a researcher, I would have actually liked to know what these studies are and it didn't tell me, it just said that, you know, somebody found this, but that was it. And it was like yeah, that's cool, that's what I get, you know, on the internet every day, that doesn't mean it's true. Not that I ... I kind of trusted the site, but I would have just liked the possibility to validate what it says [Amelia (ln 69-75)] • I don't want to deal with anything that's too wordy or too complicated or too difficult [Mia (ln 512-513)]
2.2.2.3. Suggestion	Comments relating to suggestions about the content of the DBCI	
2.2.2.3.1. New content/linking to content	A comment relating to a suggestion about new content that the individual would like to see or suggestions of links to other content	• You could just like have links in to a lot of different websites [Becky (ln 309-310)] • I also think maybe again I'd expect to see warnings about remembering things like keeping your inhaler with you [Lena (ln 551-552)]

Code Label	Description	Example Quote
2.2.2.3.2. Tailoring	A comment referring to a suggestion about more tailored DBCI and email content, including asthma or unique to the individual	• [Success stories] Yeah, yeah. If it was a bit more tailored to how your asthma is perhaps [Fraser (ln 81)] • [Emails] So, if I was going into it, or if I was somehow regularly updating whether I'd done a thing or not, then I guess I would have expected those ... those emails as sort of engagements from the system to me to customise to that, like 'hey, well done, you've done all the exercise you said you'd do this week, you don't have to do anything now,' or 'hey, you've only done one out of the four things you said you'd do, get on it,' sort of thing [James (ln 134-140)]
2.2.2.3.3. Other	A suggestion relating to content that does not fit under either of the other labels	• Maybe not everyone will want to do a quiz, so maybe having you know that kind of information more easily seen would be good [Becky (ln 658-659)] • [I]f you could have a front screen and see what's going on, and if you wanted to know more you could but you weren't bombarded with information. Because sometimes people just kind of switch off if you tell them too much because people don't like being told what to do generally do they? [Katie (ln 83-87)]

Code Label	Description	Example Quote
2.2.3. Credibility	Any comments relating to the credibility of the intervention, including suggestions	• It's good to know that when I said you know to look at the team and put faces to qualifications, that you are a proper qualified people [Maggie (ln 213-214)] • Then there was that quiz that you answered that referred to a lot of studies, being a researcher, I would have actually liked to know what these studies are and it didn't tell me, it just said that, you know, somebody found this, but that was it. And it was like yeah, that's cool, that's what I get, you know, on the internet every day, that doesn't mean it's true. Not that I ... I kind of trusted the site, but I would have just liked the possibility to validate what it says [Amelia (ln 69-75)]
2.2.4. Usability	Comments referring to the ease-of-use, efficiency, and accessibility of the system, excluding comments referring to confusion about content	
2.2.4.1. Positive	A positive comment referring to ease-of-use, excluding comments referring to navigation	• I liked how easy it was to see, because I could see it without my glasses on [Faye (ln 34-35)] • It was very simple to use [Jacobe (ln 60)]

Code Label	Description	Example Quote
2.2.4.2. Negative	A negative comment referring to ease-of-use, excluding comments referring to navigation	• On the iPad it doesn't fit on the screen [Becky (ln 219)] • I couldn't really figure out immediately how to ... like how to track that activity that I was ... like the goals that I set, tracking that activity like in a very acc- ... like an accessible way, a way that I would like I'd definitely go to and definitely involve with [James (ln 118-121)]
2.2.4.3. Suggestion	A comment that suggests an improvement to the usability of the system	• It probably could have been a little more than what there was, so, you know, you don't have to click next every single time to read the next sentence, but other than that I actually liked it [Amelia (ln 318-320)]
2.2.4.4. Navigation	Comments referring to the user's position in the system or navigating around the system	
2.2.4.4.1. Good navigation	A comment referring to the the navigation working well or being easy to use	• It's easy to go through, to access you know, there's always a 'back' button, which is, when I need to go back and forth, you know I just dot around and read a bit more [Maggie (ln 53-56)] • Yeah, really easy. Yeah. I'm trying to think. There were next buttons everywhere, quite handy [Fraser (ln 88-89)]

Code Label	Description	Example Quote
2.2.4.4.2. Not intuitive	A comment referring to the navigation not being intuitive, difficult or not working properly	• But, like a lot of the time it's a lot of clicks to get to something [Jacobe (ln 64)] • Sometimes it doesn't feel like the most intuitive design of all to go back through sort of the goals and everything else. When I first came back to use it I was kind of like okay, I've got to remember what I've done here [Lena (ln 116-119)]
2.2.4.4.3. Tunnelling	A comment relating to the tunnelled architecture that prevents an individual from choosing their own path through the system	• It kept wanting to send you to the quiz, or my browser wanted me to send, you know send me to the quiz when I'd done that already and I knew all the answers [Faye (ln 238-240)] • Something about the menu being poor, I don't necessarily remember that, but ... yeah, so it forced you to go through by clicking next every single time rather than letting you jump around [Amelia (ln 79-81)]

Code Label	Description	Example Quote
2.2.4.4.4. Locked sections	A comment referring to the locked sections of the website, including a comment that notices something is unavailable	• I don't know if I went to any locked sections. Should I have gone to locked sections? [James (ln 263-264)] • The locked sections. Oh yes, that's right, so if you haven't ... you have to do something before you can get more things, can't you, yeah. So, what was that you have to enable to get My Messages and things like that, didn't you, yeah. I suppose it was good in the sense that it made you walk through it and they wouldn't give you access to anything after that, that was fine, that seemed logical [Katie (ln 263-268)]
2.2.4.4.5. Missed sections	A comment referring to a section that the individual missed or was not aware of, either accidentally or on purpose	• [My Support] I mean I only discovered this morning about like getting advice, getting advice say for my health condition or I want to find out more about, well what was it, I want to find out about some feelings and Getting Active, I didn't actually do that bit before. You seem to have a lot of sort of hidden stuff, that would be quite good to make it a bit more you know easier to get to [Becky (ln 547-552)] • [Have you seen the Success Stories?] No [...] Where are they? I can see benefits, how to use it, messages, support [Lena (ln 163-165)]

Code Label	Description	Example Quote
2.2.4.4.6. Suggestion	A suggestion relating to the navigation, including architectural structure – of the intervention	• Please put a back button [Faye (ln 287)] • I think if there was a tab that said Success Stories, or if it has some of the other things more obviously I probably would have gone and looked at those [Lena (ln 275-277)]
2.2.4.4.7. Other	A comment that does not fit under the other labels within navigation	• [Reason for returning to a particular section?] Yeah, a bit of accidently but it was a bit trying to find out a bit more about it. So as it was coming up as well I was still trying to find out a bit more about it. Yeah no particular reason [Fraser (ln 193-195)] • It was a bit linear, you know, back, next, sort of ... I don't know, it just ... it feels that it lacks a little bit of depth to be something that I would use in the future, but that's only because, you know, you guys have designed it and you're starting out [Katie (ln 90-93)]
2.2.5. Functionality	General comments about the functionality provided by the intervention	
2.2.5.1. Quiz	An opinion or comment relating to the quiz, excluding any comments referring to content	
2.2.5.1.1. Positive	A positive comment relating to the quiz, excluding any comments referring to content	• I thought it was good [Eva (ln 83)] • [Quiz] Oh, yeah, that was fine. Yeah, it was OK. Easy-ish to use and it got me to where I wanted to be, yeah. Yeah, it was actually quite good [Mia (ln 222-223)]

Code Label	Description	Example Quote
2.2.5.1.2. Other	A comment relating to the quiz that is either negative or neutral, excluding any comments referring to content	• [Quiz] Maybe not everyone will want to do a quiz, so maybe having you know that kind of information more easily seen would be good [Becky (ln 658-659)] • It was like the first thing I did, I think [Jacobe (ln 125)]
2.2.5.2. Notifications	General comments about notifications and specifically the intervention notifications, includes suggestions for additional notifications methods	
2.2.5.2.1. Positive	A positive comment referring to the email functionality, excluding comments about content on the 'My Messages' pages	• I quite like the emails as well. I thought that was quite handy [Fraser (ln 34-35)] • I liked that you can be sent messages even though that was one feature I didn't use because I get enough messages on a daily basis but it is good having those hints [Christoph (ln 53-55)]
2.2.5.2.2. Set up	A comment referring to how an individual set up their notifications, including the frequency of emails and whether they received them	• Well, I thought well that's, I thought I had set it up for regular emails, but I don't think I got any, so [Becky (ln 389-390)] • Well I'd get an email twice a week, which I asked for [Maggie (ln 60)]
2.2.5.2.3. Prompting	Comments referring to the effect of notifications either prompting intervention usage, activity or prompting something additional	

Code Label	Description	Example Quote
2.2.5.2.3.1. Intervention usage	A comment referring to a notification that triggered usage of the intervention	• I think the emails were generally the things that, like, reminded me that oh, yeah, okay, I should go back on there and see what's going on [Jacobe (ln 237-239)] • [Prompted use?] I think it was the emails [James (ln 449)]
2.2.5.2.3.2. Activity	A comment referring to a notification that prompted the individual to do an activity or reminded them of their set activity goals	• [Emails] gives you a spur on to reach your goal use as well. Yeah I think they were quite good [Fraser (ln 124-125)] • The website is helped by the messages reminding me that that's what I ought to be doing [Grace (ln 511-513)]
2.2.5.2.3.3. Other	A comment referring to the notifications triggering something for the individual, excluding specific reference to the intervention usage or comments relating to activity or goals but including comments that are vague about what was prompted	• [Goal setting] I like the way you could, if I send it to my emails I think usually I've got my Uni ones programmed on there, so I think it's important that I actually look at it and think oh yeah, I need to do that, so I'd use that again [Faye ln 403-405] • They were helpful in that they reminded me that I was engaged in this, and that I was ... that I was doing something and that sort of had that like nudging effect of like reminding me that this is a ... this is important, this is something I need to ... need to be doing [James (ln 337-340)]

Code Label	Description	Example Quote
2.2.5.2.4. Other	Any other comment referring to the notifications from the system or suggestions, excluding any comments about the content of the emails	• It was a little bit trickier with the main interaction being through email because I ... I don't check that quite as often [Lena (ln 187-188)] • When [the intervention] started sending me emails I couldn't identify where they came from, because nowhere in the email was it talking about Getting Active, the name just disappears. And it was only ... so the email address had nothing to do with it, the title had nothing to do with it, the subject line, everything was unknown. I first thought it was spam, and then I looked at the content and figured out that this must be the reminder that the site promised, and it turned out to be but, you know, it didn't ... it was completely unclear what that was [Grace (ln 166-174)]
2.2.5.3. Goal setting	General comments relating to the goal setting function in the intervention	
2.2.5.3.1. I like that	A positive comment relating to the goal setting function of the intervention	• I like that you got, you know you can set your own goals, plus you have suggested goals [Becky (ln 78-79)] • I like the fact you could get the goals [Faye (ln 89)]
2.2.5.3.2. Setting goals	Comments referring to how the individual used the goal setting feature of the site	

Code Label	Description	Example Quote
2.2.5.3.2.1 Easy goals	A comment about setting easy goals or goals that the individual had already planned to complete	• So [the goals] were things I knew I probably did anyway [Jacobe (ln 109)] • Well so my one goal was to actually use my standing desk to stand, and I did that, but, you know, in a way that's something I would have done anyway maybe [Amelia (ln 188-190)]
2.2.5.3.2.2 Goal options not fitting requirements	A comment about the lack of options in the pre-set list or the options not fitting requirements	• The [goal] that I couldn't quite structure in the way that I wanted was that I wanted to ... I wanted to make sure I stood up every hour [...] But it almost would have been nice to be able to say that I wanted ... like that every hour was also part of a time constraint [James (ln 363-373)] • I would have expected more suggestions, more things, you know, that maybe I could do that I wouldn't have thought of myself, but this was sort of putting all of the work on me [Amelia (ln 137-139)]
2.2.5.3.2.3 Other	A comment relating relating to the goal setting that does not fit under one of the other labels	• So I set a goal at the start of the week and then I went back at the end of the week and ticked it off, kind of thing [...] Yeah, so I used to do that on a weekly basis, really [Fraser (ln 59-62)] • [Same goals as first week?] It's really the same. I mean it's like a 15-minute walk, but the goal is more like walking regularly [Grace (ln 500-501)]

Code Label	Description	Example Quote
2.2.5.3.3. Activity plan	A comment referring to the optional, printed activity plan	• [Print goals?] I created a PDF I think. I didn't actually print it [Amelia (ln 197)] • [Any reason for not printing?] Don't know. Didn't think I needed them [Mia (ln 143)]
2.2.5.3.4. Reviewing goals	Comments referring to the reviewing of goals, including how easy it was to track aspects of their goals and whether they achieved goals, and whether they saw the stars	
2.2.5.3.4.1. Granularity of tracking	A comment referring to the level of detail/granularity of tracking the set goals, including whether these meet requirements	• It's like, even if you set a goal for doing something for the next seven days that's just one tick box. It's not as you go tick off the days that you've done it, things like that [Jacobe (ln 40-42)] • Well the site only says goal or no goal [...] But if I ... you know, if I had the possibility to sort of keep it ... keep a track of what I'm doing as I'm doing it I think that might be more useful [Amelia (ln 248-258)]
2.2.5.3.4.2. Stars	A comment referring to the stars of the review process, including whether they achieved their goals, reviewed their goals, whether they were awarded stars, and whether they saw the goals	• Yes, I did. I've not ... my second goal ... yes, I have, I've achieved both of them, yeah [Mia (ln 138-139)] • Yeah. No, I haven't seen the stars [Christoph (ln 90)]

Code Label	Description	Example Quote
2.2.5.3.4.3. Other	Any other comment that does not fit under the other labels	• Yeah, and I liked the way you could put why you failed miserably [Faye (ln 117)] • Because I mean realistically at the moment [...] when I didn't meet my goal properly I said so, but equally you've kind of got here are my goals but I could just tick them off. So, there's kind of no tangible responsibility for that. Whereas on stuff like Fitbit [...] You know, it actually sort of comes up in your stats as opposed to just me being able to say well actually yes, I did even if I necessarily didn't [Lena (ln 57-65)]
2.2.5.3.5. Suggestion	Suggestions about the goal setting feature, including the setting and reviewing of goals	

Code Label	Description	Example Quote
2.2.5.3.5.1. More guidance or goal options		• Like it always told you a little bit about asthma and that you should be active, now make up some stuff how you can be active, and that's like I would have liked more guidance around that and maybe more ideas and more ... you know, more guidance in that thought process [Amelia (ln 140-143)] • I think it would be nice maybe if you had a few more choices on there because some ... you know, like I think there was walking, I dunno, maybe there was swimming, I can't remember, but like some ... like badminton, squash, tennis wasn't on there, so I don't know, maybe it would be nice to have a couple of sports listed so you didn't have to enter them every time. So ... all ... yeah, that would be good [Katie (ln 106-112)]
2.2.5.3.5.2. More detailed tracking	A desire to record more detail when reviewing or tracking goals	• I think for prolonged use I would need something in it that I could actually track myself, so like if I had you know with the steps, like because you do the step-counter [...] And then I can track that myself, and that would really encourage me to keep using it over a long period of time [Becky (ln 674-683)] • But it almost would have been nice to be able to say that I wanted ... like that every hour was also part of a time constraint [James (ln 371-373)]

Code Label	Description	Example Quote
2.2.5.3.5.3. Visual representation of data/Tracking over time	A suggestion about recording or tracking goals or other data over time, including comments about the presentation of data	• So you sort of click on my goals and then it's showing me this week's goal, whereas it could be presented in like a dashboard or something where all that information is available to you [Jacobe (ln 66-68)] • Maybe you could enter your weekly step count or something from your tracker so you could keep a little bar graph of how many steps you've done a week or a month if you want [Katie (ln 168-170)]
2.2.5.3.6. Other	A comment referring to the goal setting feature that does not fit under the other labels	• I feel really [Pilates] could be on there, because a lot of people, well especially my age, we haven't got vehicles, we have to catch buses or walk [Maggie (ln 190-191)] • I mean sort of I didn't know that the website would actually track what I do. I knew that I could put up my goals but I wasn't clear that there was sort of follow-up on that [Amelia (ln 231-233)]
2.2.5.4. Desired functionality	A comment suggesting additional functionality, excluding suggestions about the goal setting feature	

Code Label	Description	Example Quote
2.2.5.4.1. Recording additional elements	A suggestion to record additional data in the intervention, including asthma and other health related data	• One area where it could have been more useful is if you could enter any sort of other conditions or anything like that, that at the moment is stopping you from being more active [Jacobe (ln 207-209)] • I thought the only thing that was kind of missing was maybe a part where you could log how you're feeling as well. So you could match them up with how you're feeling and what kind of exercise you do. I thought that might have been useful [Fraser (ln 40-43)]
2.2.5.4.2. Interoperability with other apps	A comment asking for the intervention to link and integrate with other apps or websites, including automatic tracking of exercise	• [Syncing with your phone] I think that would be useful [Faye (ln 187)] • Or if it synced with my Fitbit or something like that then it might be handy [Fraser (ln 210-211)]
2.2.5.4.3. Other types of notifications	A comment asking or suggesting an alternative method of notifications, rather than email	• It would also be really nice to be able to set reminders for stuff, like on things like remember to be doing this, that, or the other before you do your exercise [Lena (ln 92-94)] • But yeah, I mean in the future if you made it like a ... if you made it like an app, a nice notification to your phone would be great sort of thing [Katie (ln 409-411)]

Code Label	Description	Example Quote
2.2.5.4.4. Linking with other users (Social networking)		• I guess it seems these days the most engaging thing are like, where you can see what your friends are doing and things like that [...] So, like, some kind of social motivation, I think could be, certainly for me, would probably be useful [Jacobe (ln 253-259)] • I really like that you can compete [using Fitbit] against your friends in it, because I like the gamified app, and I really like the leader board where you can see how all your friends have done steps-wise, and that you can do different types of competitions [Lena (ln 490-493)]
2.2.5.4.5. App format	A comment asking for the intervention to be in an app format	• Also offering an app because I think this was only a website. And, you know, a website is something that I would ... I would usually engage with that sort of thing only when I'm sat at my computer [...] Doing it in an app much more likely [Amelia (ln 652-657)] • I think because it's a web platform it's a little harder, for me [...] So, yeah, I think if it was an app format that would be even more easy to use, like it would be on the front screen of my phone and I'd be like oh yeah [Katie (ln 297-305)]

Code Label	Description	Example Quote
2.3. Support	Comments referring to support required or provided by the intervention, excludes comments referring to support for illness management or carrying out the desired activity	• Well I like to see when you see the team, see their faces with the names that you have [...] You know that was, that was quite interesting [Maggie (ln 93-96)] • [Help accessing the site?] Yeah, my husband, [partner's name]. He helps me out a lot. If I want to do anything on the computer then he does it for me [Eva (ln 9-10)]
2.4. Emotion	A comment showing an emotional reaction to the intervention or its usage	• [I]t's very calming colours [Becky (ln 520)] • I was quite annoyed by the design of it [...] you learn that different colour text means there's a link, but there isn't. So, I tried clicking everywhere and there was just nothing, and that really pissed me off [Amelia (ln 52-59)]
3. Audience	A comment which shows an emotional reaction to the intervention or interactions with the intervention	
3.1 Target audience	A comment about who the user thinks the target audience is, should be or the appropriateness of the intervention for different users	• I think it would be good for older people, but sometimes if you were trying to target the, anyone like younger, it might be a little bit boring for them [Faye (ln 305-307)] • If you were someone who wasn't already active it would be good in getting you going [Katie (ln 64-65)]

Code Label	Description	Example Quote
3.2 Recommend to others	A comment about who the user thinks the target audience is, should be or the appropriateness of the intervention for different users	• [Would you recommend?] Oh yes, definitely, yes, yeah [Maggie (ln 408)] • I might recommend it to people, like I feel like I know people with asthma who don't necessarily have that activity as part of their schedule. So, like I definitely see value in it. I don't know how much I'd use it [James (ln 473-475)]
4. Related apps & websites	Comments about a similar app or website, including any comparisons, evaluations of other sites and products they already use	
4.1. Comments about other apps/websites	A comment about a similar app or website, including products that they already use or know about but excluding direct comparisons between Getting Active and other apps	• I've got on my iPhone I have the Health App on my iPhone [Becky (ln 565)] • I've used like, I downloaded an App when I was trying to get a bit healthier, that counted your calories and set prompts to, I can't remember what it's called though, but you could set paths for exercise [Faye (ln 329-331)]
4.2. Comparing to other apps/websites	A comment directly comparing Getting Active to another app or website, excluding general comments about the app or website	

Code Label	Description	Example Quote
4.2.1. Positive comments about Getting Active	A comment comparing and emphasising something positive about Getting Active over another app or website	• I think [the intervention is] much more of an interactive thing, because the NHS stuff I've been on hasn't been that interactive and I do like that about this [Becky (ln 560-562)] • I think you've done it very well. I'm very pleased with it. I know the Breathing Easy one last year, I had a little bit of, found annoying was the colours of the pages, but I think you've done it very well on this site [Maggie (ln 198-201)]
4.2.2. Positive comments about another app/website	A comment comparing and emphasising something positive about another app or website over Getting Active	• [Had to use the 'other' option] and then it wouldn't let me write the whole thing, like the whole what kind of exercise I wanted to do, whereas the [other] Apps might let you do that [Faye (ln 356-358)] • Thinking about it in comparison to like modern websites it has a feel of something that maybe is not so sleek [Jacobe (ln 162-164)]

Code Label	Description	Example Quote
4.2.3. Other	A comment comparing Getting Active to other apps or websites that does not fit under the other labels, including negative comments about Getting Active in comparison to other options	• [Getting Active offer anything extra?] Erm...other than the tips in the beginning and the facts kind of thing I don't particularly think so [Fraser (ln 229-230)] • I think if you've already got like a fitness tracker and all that sort of thing, this app might be a bit redundant for you, or this website platform [Katie (ln 170-172)]
4.3. Suggestion based on another app/website	A suggestion explicitly for Getting Active that is based on another app or website	• Because like for stuff like sleep apps, like the sleep app I use every day, when I wake up it goes how would you rate your sleep [...] which, you know, is never good, but it would be ... probably be good to be able to rate stuff like how was your exercise [Lena (ln 83-87)] • I mean no, it's also, it's the having to go in and say, "Yes, I've done that," whereas it's ... this is done automatically. If you can connect things to ... if you can connect it to other apps or to other devices, that would obviously make the whole thing easier [Christoph (ln 105-108)]

Table F.9: Getting Active (Stage 2): 'Illness' DisENGAGE Codebook

Code Label	Description	Example Quote
1. History of illness	A comment referring to the individual's history of the illness, when they were diagnosed, recalling childhood memories, or a bad attack	• I was diagnosed quite late in life, at sixteen, rather than a kid [Faye (ln 408-409)] • When I was younger I was in hospital a lot, I had to ... you know, I remember like the first ... when I went to university and I didn't take my nebuliser with me that was like a serious step, so, you know [Katie (ln 575-578)]
2. Triggers for illness	Comments that refer to the triggers for that individual's illness	• I've often thought that with mine, you know as I say, everybody's different, but whether diet takes, or you know so when I feel there must be things sometimes that are you know a few, if I eat cheese or what else is there, chocolate, red wine, that makes me breathless [Maggie (ln 387-390)] • At the moment they've got it under control. I only get really, really bad if it's really hot [Eva (ln 155-156)]
3. Severity	A comment referring to the severity of the individual's illness, excluding how controlled their asthma is	• I've only got it mildly [Fraser (ln 12-13)] • My asthma isn't ... fortunately isn't very severe [Amelia (ln 418-419)]
4. Self-management	Comments referring to how the individual personally deals with their illness, including attempts to manage it, and failed attempts of management	

Code Label	Description	Example Quote
4.1. Knowledge	Comments relating to the individual's current knowledge about their illness or their approach to knowledge	
4.1.1. I know that	A comment referring to knowledge (about their illness) that the user already had – i.e. how knowledgeable they are about their illness	• [Quiz] answers to the quiz were pretty obvious to me, but it could be just because I'm a science student [Faye (ln 397-398)] • [What did you learn?] Nothing particular I don't think. Nothing I haven't heard before it's just emphasised [Fraser (ln 45-46)]
4.1.2. Other	Any other comment about knowledge relating to the illness, including lack of knowledge	• [Looked at other asthma sites?] I guess not. I think most of it's come from engagement in like sport, and sport and fitness. I'm trying to think if I've looked at any specific asthma resources [James (ln 85-87)] • You know, why the whole getting active thing was interesting because that's why ... you know, that's the part I didn't know [Amelia (ln 424-425)]
4.2. Attitude/Self-care	Comments about how the individual actively manages their illness or their attitude towards their illness, including how controlled it is and their medication helps achieve this. It excludes emotions and feelings about their illness but includes comments about their general health	• [D]ay-by-day I don't even consider [my breathing] you know, I just get on with life [Maggie (ln 36-37)] • I'm always interested in stuff to do with asthma because I've been an asthmatic a long time, and it's quite under control but I'm always prepared to try new things to keep it basically out of my life [Katie (ln 30-32)]

Code Label	Description	Example Quote
4.3. Support	A comment referring to the support that the individual receives to handle their illness, including the use of medication	• Well medication obviously. And that's pretty much it [Amelia (ln 418)] • I go to the doctor and ... and I, sorry, the nurse ... I go to clinic once a year, and they do a nurse, whatever it is, the nurse, asthma nurse [...] I don't use the blue one very often, although I have, because I've had a cough in the last couple of weeks, so I've used that a lot more [Mia (ln 430-434)]
5. Emotions	A comment referring to an emotion or feeling about the individual's illness	• [W]hen you've got asthma it's kind of scary in case you're going to have an attack when you exercise [Fraser (ln 18-19)] • [I]t was seriously worrying me walking up the hill and losing my breath like that [...] the last time I did go up there I ended up not as out of breath as I had been previously [Grace (ln 246-250)]

Table F.10: Getting Active (Stage 2): 'Activity' DisENGAGE Codebook

Code Label	Description	Example Quote
1. Knowledge	A comment referring to their knowledge of activity and its relationship with the illness	• [A guide to steps about] Ten thousand steps a day [...] Oh that's helpful, because as I say I didn't know [Maggie (ln 158-163)] • You know, why the whole getting active thing was interesting because that's why ... you know, that's the part I didn't know [Amelia (ln 424-425)]
2. Activity levels	Comments relating to individual's activity levels both before and after using Getting Active	
2.1. Activity before Getting Active	A comment referring to the individual's activity level before using Getting Active	• So I'm not actually doing a huge amount of activity [Jacobe (ln 192-193)] • I'm very active, but I don't do ... the trouble is, I don't do focused exercise. So I'm in and out ... I will be non-stop on the go pretty much from probably about 8 in the morning, 8 or 9 in the morning until 10 or 11 at night, most nights [Mia (ln 335-338)]
2.2. Activity after using Getting Active	A comment referring to the individual's activity level after using Getting Active	• Well I think I am walking a bit further [Maggie (ln 236)] • Yeah, I definitely walk more. I think that was the goal I set during the week. I definitely got walking a bit more [Fraser (ln 140-141)]

Code Label	Description	Example Quote
3. Barriers to activity	A comment relating to an individual's barriers that prevent their activity, before and after Getting Active	• I got bogged down with Uni work, but I appreciate the sentiment, and like would do it if I didn't get bogged down with Uni work [Faye (ln 109-110)] • The second week I was supposed to do squash and badminton and walking, and I didn't because work ran over so I didn't get to go after work. And then this week I knew I wasn't going to do it so I think I just put walking in [Katie (ln 134-137)]
4. Overcoming barriers	A comment referring to tools or techniques that help an individual overcome barriers to activity, including comments about the intervention	
4.1. Purposeful exercise	A comment relating to a need for activity to be meaningful or has a purpose that goes beyond exercise just for the sake of exercise	• [S]ometimes you can procrastinate clean, which is good, because that's exercise, and you are doing something useful at the same time [Faye (ln 61-63)] • I don't like the idea of just going to the gym and going on a machine, and just for the sake of it. I mean I have in the past and it's ... but it's been for a purpose, it's been to either lose weight or, you know, usually to tone up and get fit [Grace (ln 301-304)]

Code Label	Description	Example Quote
4.2. Small actionable goals/tracking		• The other tracking that I've ever done before there's not really been a good like small and short-term goal setting, or that I've really engaged with. So, I sort of found it useful to have ... to have help being reminded of that is my ... that is a goal that I have like even just like this week, or these few days I found it valuable for that [James (ln 403-408)] • Incremental tracking. So, what I really liked about my old gym [...] measures everything [...] then sends that to the app, and then the app spoke to my other app which was My Fitness Pal which is where I collected everything that I did in the gym [...] And I found that really motivating because it told me exactly what I had done [Amelia (ln 572-581)]
4.3. Planning	A comment referring to the need to plan in activity to overcome any barriers	• If you were in bed or something and you could just try and plan your activities for the next week or the next day, so that was good [Faye (ln 35-37)] • I'm going away this week, take stock, come back, and put this in the diary first, put these kind of things in the diary first, and make these a priority [Mia (ln 88-90)]

Code Label	Description	Example Quote
4.4. Other	Any other comment referring to how the individual overcomes their barriers to activity	• [T]he grandchildren were here so we would go out for a walk, or we would go for a run around outside that would be the equivalent of that [Grace (ln 659-661)] • [I]n the gym I have air conditioning, and that means I have rather cold air, I have clean air, and that makes it easier for me to breathe. So, you know, I couldn't go running outside in the summer because I would suffocate [Amelia (ln 487-490)]
5. Thoughts about activity	Comments relating to how the individual feels about activity or exercise, including how they felt after increasing their activity levels and their attitude towards activity	
5.1. Positive	A positive comment about activity	• [Will you carry on trying to walk?] Definitely. Because I'm noticing positive benefits from that, and I've realised I actually quite like doing more walking and using my car less [...] in general I'm feeling more active and like a lot heathier than I've been in the past [Lena (ln 439-444)] • Because when I did all three [activities] I felt really good about it [Katie (ln 442)]
5.2. Negative	A negative comment about activity	• [walking to and from work] It was a bit creepy because it was quite late [Faye (ln 209)]
5.3. Other	A comment about activity that does not fit under one of the other labels	• [Use of the app to get fit] I think I'm trying to find easy options [Mia (ln 38)]