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User Acceptance of Health and Mental Health Care Technologies

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Declaration

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Camille Nadal

Thursday 14th July, 2022

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A mes grand-parents, Annie, Jean, Danièle et Lucien.

Abstract

Health and wellbeing is a rapidly growing area within Human-Computer Interaction (HCI). In recent years, many have developed systems, theoretical stances, and methodologies that aim at positioning information and communication technologies as an important component of strategies for diagnosis, treatment, prevention, or self-management for people facing health or mental health difficulties. Technology has opened the door to a multitude of opportunities for improving health and mental health interventions. Particularly, recent innovations such as wearable devices, embedded sensors, and machine learning show great potential for enhancing the effectiveness, tailoring, and convenience of traditional interventions. Designing technologies for health and wellbeing requires negotiating a complex design space, for which various design philosophies building on User-Centred Design, and validation methods have been proposed, all associated with a range of challenges and opportunities.

While clinical effectiveness is critical to the success of technology-supported health and wellbeing interventions, a lack of user acceptance will impede individuals' uptake and long-term use of the technology. Due to the longitudinal nature of healthcare, non-use or discontinued use of technology in this context risks exacerbating the issues of lack of adherence to treatment and drop-out. User acceptance is therefore a core challenge for successful health and mental health technologies. In addition, this question requires consideration as early as design stage, and throughout the user journey with technology. The theoretical landscape of user acceptance is rich, and includes a wide range of definitions, models, and measurement methods. However, the ambiguous use of terminology, and large number of both validated and ad-hoc models available make the application of acceptance theory into design and research practices a complex task.

This thesis examines how to support design for, and measurement of user acceptance of health and mental health care technologies. It asks how to guide designers of digital health and wellbeing technologies in leveraging the theory of user acceptance in design practice, and how to capture a rich picture of the evolution of user acceptance in clinical settings. Through collaboration with digital health researchers, designers, patients, and mental health professionals, this thesis attempts to bridge the gap between theory and practice.

This thesis first contributes to our knowledge on how user acceptance is addressed in research practice, including how the concept is defined, discussed, designed for, and measured. It identifies differences that exist between research practices and existing theoretical frameworks, and contributes to the clarification of the process of technology acceptance by (i) defining *user acceptance* and the *user acceptance journey*, and (ii)

proposing the Technology Acceptance Lifecycle (TAL), a temporal, theory-based model consolidating existing definitions, articulating the different stages of technology acceptance — namely *pre-use acceptability*, *initial use acceptance*, and *sustained use acceptance* — and providing an explicit terminology.

This thesis then proposes and examines a novel, theory-based approach to designing for user acceptance of health and mental health care technologies. This approach consists of a design tool and method, the *TAC toolkit*, which supports designers in leveraging user acceptance theory in the design of health and wellbeing technologies. The *TAC toolkit* method was evaluated with 21 digital health designers. Findings indicated that the method (i) revised and extended designers' knowledge of user acceptance, (ii) fostered their appreciation, empathy, and ethical values while designing for acceptance, and (iii) motivated the future use of the toolkit in their design practice.

This thesis finally investigates a novel, theory-based longitudinal approach to evaluating user acceptance in the context of mental health care, following the TAL timeline. As a practical example to implement such a longitudinal theory-based approach, we developed the *Mood Monitor* — an application for smartwatch intended to facilitate mood and lifestyle habits self-monitoring in depression treatment. This practical case study took the form of an 8-week randomised controlled clinical trial (n=69), examining patient acceptance of the Mood Monitor watch app in a routine internet-delivered therapy for depression. This thesis shows how the results of the case study exploring the longitudinal measurement method can inform the technology design, and identifies challenges of conducting user acceptance research in clinical settings.

This thesis enriches the HCI field with a better understanding of user acceptance, and how the concept can be designed for and measured, in the context of digital health and wellbeing.

Résumé

Les questions de santé et de bien-être psychologique prennent de plus en plus d'ampleur dans le domaine de l'Interaction Humain-Machine (IHM). Ces dernières années ont vu l'apparition de nombreux systèmes, théories, et méthodologies, positionnant les technologies de l'information et de la communication comme éléments clés de stratégies de diagnostic, traitement, prévention, et autogestion pour les personnes rencontrant des soucis de santé. La technologie a ouvert la porte à une multitude d'opportunités pour optimiser les interventions de santé et bien-être. En particulier, les récentes innovations que sont les technologies portables, capteurs embarqués, et l'apprentissage automatique ont le potentiel d'améliorer les interventions traditionnelles en les rendant plus efficaces, pratiques, et mieux adaptées aux besoins des personnes.

Le développement de technologies de santé et bien-être psychologique demande aux concepteur·ice·s d'IHM de naviguer un espace de conception complexe, pour lequel de nombreuses philosophies de conception s'appuyant sur la Conception Centrée Utilisateur·ice, et méthodes d'évaluations existent, toutes associées à un éventail de défis et opportunités.

Bien que l'efficacité clinique des interventions de santé digitale soit essentielle à leurs succès, le manque d'acceptation technologique des utilisateur·ice·s peut entraver la prise en main de la technologie, et son utilisation à long-terme. En raison de la nature longitudinale des soins de santé, la non-utilisation ou utilisation discontinue de la technologie dans ce contexte risque d'exacerber les problèmes de manque d'observance et d'abandon de traitements. L'acceptation technologique constitue donc un enjeu majeur pour le succès des interventions de santé digitale. De plus, cette question doit être considérée dès la phase de conception, et tout au long du parcours des utilisateur·ice·s avec la technologie. L'espace théorique de l'acceptation technologique est riche, et inclut une large palette de définitions, modèles, et méthodes de mesure. Cependant, une utilisation ambiguë de la terminologie, et le grand nombre de modèles publiés (validés ou non) rendent complexe l'application des théories de l'acceptation technologique au sein des pratiques de conception et de recherche.

Cette thèse examine comment guider la conception et mesure de l'acceptation technologique dans le domaine de la santé physique et mentale. Nous nous interrogeons sur les façons (i) d'accompagner les concepteur·ice·s d'interventions de santé digitale dans l'intégration des théories de l'acceptation technologique au sein de leurs pratiques de conception, et (ii) de capturer une image complète de l'évolution de l'acceptation technologique dans un contexte clinique. S'appuyant sur une collaboration avec des chercheur·se·s de santé

digitale, concepteur·ice·s d'IHM, patient·e·s, et personnels de santé, cette thèse tente combler l'espace entre théorie et pratique.

La première contribution de cette thèse est un avancement des connaissances en matière de recherche sur l'acceptation technologique, notamment comment les chercheurs·es définissent, caractérisent, et adressent ce concept dans les pratiques de conception et d'évaluation. Nous spécifions l'écart entre pratique réelle et cadres théoriques, et contribuons à la clarification du processus d'acceptation technologique (i) en définissant les notions d'*acceptation des utilisateur·ice·s* et du *parcours d'acceptation technologique*, et (ii) en proposant le Technology Acceptance Lifecycle¹ (TAL), un nouveau modèle consolidant les définitions existantes, articulant les différentes étapes de l'acceptation technologique — à savoir *acceptabilité de pré-utilisation*, *acceptation d'utilisation initiale*, et *acceptation d'utilisation prolongée* — et fournissant une terminologie explicite.

Ensuite, cette thèse propose et examine une nouvelle approche ancrée dans la théorie, visant à guider la conception pour l'acceptation technologique. Cette approche prend la forme du *TAC toolkit*, un outil et méthode accompagnant les concepteur·ices de technologies de santé physique et mentale, dans la mise en pratique des théories de l'acceptation technologique. La méthode du *TAC toolkit* a été évaluée par une série de 7 ateliers avec 21 concepteur·ices d'interventions de santé digitale. Les résultats indiquent que la méthode a permis (i) de réviser et étendre les connaissances des concepteur·ices en matière d'acceptation technologique, (ii) d'encourager leurs compréhension, empathie, et valeurs éthiques lors du processus de conception, et (iii) de motiver l'utilisation de l'outil dans leur pratique future.

Enfin, cette thèse explore une nouvelle approche longitudinale ancrée dans la théorie, visant à évaluer l'acceptation technologique dans le contexte des soins psychologiques, et en suivant la chronologie établie par le TAL. Nous prenons comme exemple pratique pour l'implémentation de ce type d'approches longitudinales le *Mood Monitor* — une application pour montre connectée conçue pour faciliter l'auto-évaluation de l'humeur — développé pour l'occasion. Cette étude de cas s'est déroulée sous la forme d'un essai clinique contrôlé et randomisé, examinant l'acceptation des patients (n=69) pour le *Mood Monitor*, dans le cadre d'un traitement de routine pour dépression. Cette thèse démontre comment les résultats de l'étude de cas, explorant l'approche longitudinale pour mesure de l'acceptation technologique, peuvent informer la conception de la technologie. Pour finir, cette thèse identifie les enjeux pour la conduite de recherches sur l'acceptation technologique dans un contexte clinique.

Cette thèse enrichie le domaine de l'IHM d'une meilleure compréhension de l'acceptation technologique, et de moyens pour concevoir et mesurer le concept dans le contexte de la santé digitale.

¹Cycle de vie d'Acceptation Technologique

Associated Publications

Journal Papers

Nadal, C., Earley, C., Enrique, A., Vigano, N., Sas, C., Richards, D., Doherty, G. (2021) Integration of a smartwatch within an internet-delivered intervention for depression: Protocol for a feasibility randomized controlled trial on acceptance. *Contemporary Clinical Trials*, 106323.

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Chapter 1

Introduction

This thesis examines how to support design for, and measurement of, user acceptance of health and wellbeing technologies. It reviews existing theories and practices, identifies associated challenges and opportunities, and attempts to bridge the gap between theory and practice.

1.1 Overview

This section presents an overview of the concept of user acceptance of health and wellbeing technologies, and describes the associated challenges and opportunities which motivate this PhD work.

1.1.1 Technologies for Health and Mental Health Care

Health and wellbeing is a rapidly growing area within Human-Computer Interaction (HCI). In recent years, many have developed systems, theoretical stances, and methodologies that aim at positioning information and communication technologies as an important component of diagnosis, treatment, prevention strategies or self-management for people dealing with health and mental health difficulties. The growing interest in health technologies reflects an effort to tackle long-standing issues in health and mental health care.

Difficult access to care is one of the main obstacles faced by individuals experiencing difficulties with their health and/or mental health. The cost of health services plays a major role in creating disparities in the population, with people with lower socioeconomic status facing a longer waiting time (Schröder, Richter, Schröder, Frantz, & Fink, 2016), or being unable follow treatment until completion (Einarsdóttir, 2018). The lack of services in some geographical areas is also an important barrier to seeking and getting care (Kroelinger et al., 2019; Ekuma, 2018). In addition, some communities are particularly vulnerable to health-related stigma, preventing them from seeking help. These communities include racial and ethnic minorities, LGBTQIA+ individuals¹, and refugees, who face increased stigma due to “lack of social and economic stability, fear of encountering stigma, and increased self-stigmatization” (Kane et al., 2019, p. 33). Attempting to facilitate

¹Lesbian, Gay, Bisexual, Transgender, Queer, Intersex, Asexual, and others identities.

access and increase care availability, more and more national health services are offering internet-delivered treatments (Clark, 2018).

Moreover, we notice an increasing number of chronic health conditions related to lifestyle, such as obesity and chronic backache. Unhealthy food habits, sedentariness, wrong body posture, and disturbed circadian rhythms are factors contributing to these so-called ‘lifestyle diseases’ (M. Sharma & Majumdar, 2009). This has motivated the emergence of self-monitoring technologies such as mobile apps for the monitoring of sleep, exercise (Health app, 2021) and calorie intake (MyFitnessPal, 2021; MyDietCoach, 2021), and behavioural change technologies, such as apps rewarding exercise (Sweatcoin Walking Step Counter, 2021) or encouraging mindfulness and meditation (Pause: daily mindfulness, 2021; Headspace: Meditation & Sleep, 2021; Calm: Sleep & Meditation, 2021).

Finally, we see the emergence of systems aiming to empower individuals “to self-care and handle their own healthcare” (Silva, Rodrigues, de la Torre Díez, López-Coronado, & Saleem, 2015, p. 265), for instance, by the means of mobile apps tracking menstrual cycles (Flo Period & Ovulation Tracker, 2021).

New technologies, originally created for use in everyday life (e.g. smartwatches), or entertainment (e.g. virtual reality headsets), are increasingly employed in health and mental health care. A particular interest for these technologies is that they allow for biofeedback. Examples of the use of biofeedback include displaying the user’s heart rate to induce a relaxation response (Plans et al., 2019), providing heartbeat-like haptic stimulation as a calming effect (Azevedo et al., 2017), or heart rate variability coherence training for emotion regulation (May, Seibert, Sanchez-Gonzalez, & Fincham, 2019).

Designing healthcare systems to support users with health or mental health issues is, by its very nature, a delicate endeavour, addressing vulnerable user groups, requiring that ethical considerations are taken into account. These novel forms of care, often implying the collection of personal, sensitive data through sensors, raise additional ethical questions. Although not yet common practice, it is argued that involving the different relevant stakeholders in the process of design would help designers form a better understanding of the realities of individuals living with health or mental health difficulties (Sanches et al., 2019a).

Finally, while clinical effectiveness is critical to the success of technology-supported health and wellbeing interventions, a lack of user acceptance will impede individuals’ uptake and long-term use of the technology (Sekhon et al., 2017). Due to the longitudinal nature of healthcare, non-use or discontinued use of technology in this context risks exacerbating the issues of lack of adherence to treatment and drop-out. User acceptance is therefore a core challenge for successful health and mental health technologies, and a question that requires consideration as early as design stage, and throughout the technology lifecycle.

1.1.2 User Acceptance of Technology

User acceptance, which we define in Chapter 3 as *individuals’ perception of the technology leading to its use or non-use*, is impacted by numerous factors related to aspects intrinsic to individuals, their environment, and relationship with technology. The past three decades have seen the publication of multiple models

articulating the impact of these factors on one's intention to use and use of technology. User acceptance research has primarily focused on the workplace context (F. Davis, 1986; Venkatesh & Davis, 2000; Venkatesh, 2000; Venkatesh & Bala, 2008), before considering exploring a wider range of context (Venkatesh et al., 2003, 2012; Connelly, 2007). In recent years, the literature has started to address acceptance of health and wellbeing technologies (Kim & Park, 2012; C.-L. Hsu, Lee, & Su, 2013; Dou et al., 2017; Cheung et al., 2019; Schomakers, Lidynia, & Ziefle, 2019; Dhagarra et al., 2020). In addition, an evolving terminology and range of definitions can be found in the literature discussing technology acceptance. The effort of the research community to expand acceptance theories to the health domain has resulted in (i) a wide range of models and definitions, presenting various sets of influencing factors, and (ii) an absence of theories specific to user acceptance of mental health technologies. User acceptance of mental health technologies, in particular, is a complex notion, as some mental health difficulties, such as depression, impact users' perception of their lived-experience with the technology (Qu, Sas, & Doherty, 2019). As a result, this large – yet incomplete – set of theories renders the field difficult to navigate for designers of health and wellbeing technologies, making both designing for and measuring user acceptance, complex tasks.

The User Acceptance Journey

A strand of the literature has argued for considering user acceptance as a multi-stage process, instead of a discrete measure (Sekhon et al., 2017; N. Martin, Erhel, Jamet, & Rouxel, 2015; Distler, Lallemand, & Bellet, 2018; Terrade, Pasquier, Reerinck-Boulanger, Guingouain, & Somat, 2009; Garces, Rakotondranaivo, & Bonjour, 2016; Somat, Jamet, Menguy, Forzy, & El-Jaafari, 2012; Rogers, 1983), and attempted to use terminology to distinguish between these stages (e.g. *acceptability*, *acceptance*, *adoption*). The argument that different stages punctuate the user journey with technology – where they, consciously or not, repeatedly make the decision to keep using the system or to abandon it (Salovaara et al., 2011) – aligns with the HCI body of work which highlights the importance of temporality in user experience research (Forlizzi & Battarbee, 2004; Hassenzahl & Tractinsky, 2006). Given the longitudinal nature of care, insufficient technology acceptance increases the risk of discontinued use of health and wellbeing technologies and drop out from technology-supported treatment: a patient may take up a new health device as part of an 8-week treatment, and discontinue its use after the first couple of days. It is therefore critical to understand and address the facilitators and barriers to user uptake and long-term use of health and wellbeing technologies.

Considering the complexity of the theoretical frameworks on user acceptance and the multi-dimensional nature of the concept, there is value in exploring tools and methods for (i) bridging the theory and practice by facilitating design for acceptance, and (ii) guiding longitudinal evaluation of user acceptance, particularly in sensitive clinical contexts.

1.2 Research Questions

This thesis aspires to support designers of health and wellbeing technologies, both in designing for long-term user acceptance, and measuring acceptance across the different stages of the user journey. Specifically, this thesis aims to answer the following questions:

1. How is user acceptance of health and wellbeing technologies defined, discussed, designed for, and measured, both in theory and in practice?
2. How can the theoretical landscape of user acceptance, including the temporal dimension of the process, be made more accessible to designers of health and wellbeing technologies, and incorporated into real design practice?
3. How can we evaluate user acceptance longitudinally, in a mental health care context, and draw on the results to inform the technology design? What are the challenges of conducting user acceptance research in clinical settings?

1.3 Contributions

This thesis contributes to the field of HCI, and particularly the question of user acceptance, both on a theoretical and practical level. The contributions of this PhD work include:

- An extension of the knowledge about how user acceptance is addressed in research practice, including how the concept is defined, discussed, and measured, in comparison with existing definitions and models. This thesis identifies potential gaps, and contributes to the clarification of the process of technology acceptance by (i) defining *user acceptance* and the *user acceptance journey*, and (ii) proposing the Technology Acceptance Lifecycle (TAL), a temporal, theory-based model consolidating existing definitions, articulating the different stages of technology acceptance, and providing an explicit terminology. This work has been published in JMIR (Nadal, Sas, & Doherty, 2020).
- The exploration of a novel, theory-based approach to designing for user acceptance of health and wellbeing technologies. This approach consists of a design tool and method, the *TAC toolkit*, which supports designers in leveraging user acceptance theory in the design of health and wellbeing technologies, by revising and extending their knowledge of technology acceptance, fostering their appreciation, empathy, and ethical values while designing for acceptance, and motivating its future use in their design practice. The TAC toolkit was validated by means of workshops with 21 designers of health and wellbeing technologies. This work has been accepted for presentation and publication at CHI2022.
- The investigation of a novel, theory-based longitudinal approach to evaluating user acceptance in a mental health care context, following the TAL timeline. This thesis describes a practical case study

exploring this method, by means of an 8-week randomised controlled clinical trial evaluating user acceptance of a self-monitoring technology (the Mood Monitor watch app) in patients undergoing depression treatment. It also discusses the challenges in operationalising the longitudinal measurement method in controlled clinical settings. This work has been published in *Contemporary Clinical Trials* (Nadal, Earley, et al., 2021).

- The Mood Monitor smartwatch app. This application was developed with two aims. First, it intends to facilitate mood and lifestyle habits self-monitoring in patients undergoing treatment for depression. Second, the Mood Monitor serves as a practical example for the clinical case study, exploring the longitudinal evaluation of user acceptance of this technology. This work is being submitted for publication.
- A practical example of data analysis and reflection on user acceptance longitudinal data, resulting from the clinical case study with the Mood Monitor. This thesis shows how implementing the proposed longitudinal measurement approach can inform the technology design, by identifying a set of implications for designing self-monitoring clinical interventions on smartwatch. Finally, this thesis discusses the challenges of conducting user acceptance research in clinical settings, and advances the knowledge on methods for the evaluation of user acceptance of mental health care technologies, so far under-explored in the field.

1.4 Thesis Structure

The remainder of this thesis is organised as follows:

Chapter 2 — Literature Review

This chapter examines the notion of user acceptance of health and wellbeing technologies. It first reviews the theoretical frameworks associated with health and wellbeing technologies, including approaches to design and validate such systems in clinical settings. Then, it explores the concept of temporality in Human-Computer Interaction and associated theories. Finally, this chapter examines the theoretical landscape of user acceptance, and particularly in the context of technologies for health and mental health care.

Chapter 3 — Discussing & Measuring User Acceptance in Practice | Scoping Review

This chapter explores how researchers involved in the creation of health and mental health technologies understand the notion of user acceptance and make use of the existing theoretical frameworks — definitions, models, and measurement methods — in the evaluation of these systems. It presents a scoping review of the literature, outlining research practices addressing user acceptance in the domain of mobile health technologies, and revealing the potential limitations and areas for improvement of existing models. Informed by this analysis, we define the notions of *user acceptance* and *user acceptance journey*, and propose the Technology Acceptance Lifecycle (TAL), a temporal, theory-based model articulating the different stages of the user acceptance process — namely *pre-use acceptability*, *initial use acceptance*, and *sustained use acceptance* — and

providing an explicit terminology.

Chapter 4 – Supporting Design for User Acceptance of Health & Wellbeing Technologies | TAC Toolkit

This chapter investigates a method to support designers in addressing user acceptance of health and mental health care technologies at design stage. This approach takes the form of the TAC toolkit, a novel, theory-based design tool and method embedding a wide range of validated factors of acceptance, and the temporal dimension of the process. We present the design of the toolkit, and its evaluation with 21 designers of health and mental health technologies. Finally, this chapter discusses implications for considering user acceptance as a dynamic, multi-stage process in design practice, and better supporting designers in imagining distant user acceptance challenges.

Chapter 5 – Longitudinal Measurement of Acceptance | A Clinical Study in Mental Health Care

This chapter proposes a novel, theory-based longitudinal approach to evaluating user acceptance following the TAL timeline, and describes the protocol for a case study operationalising this method in a mental health care context. We present the Mood Monitor smartwatch app, a practical example for the study of user acceptance in a mental health care context. We then describe the protocol for the case study of acceptance of the Mood Monitor smartwatch app in the context of an 8-week randomised controlled clinical trial with patients undergoing a routine treatment for depression. Finally, we detail the longitudinal approach to measure acceptance, aiming to (i) evaluate the level of patient acceptance of the Mood Monitor and its evolution over time, (ii) identify the facilitators and barriers to acceptance, and (iii) explore the potential between-group differences, introduced by the addition of the smartwatch, in terms of acceptance of self-report, actual use of self-report, use of the iCBT intervention, and clinical outcomes. This chapter finally discusses the issues associated with the implementation of this method in a clinical mental health care context.

Chapter 6 – Analysing & Reflecting on Longitudinal Acceptance Data | Results of the Case Study

This chapter draws on the results of the clinical case study, which involved 69 patients. It first analyses the longitudinal acceptance data gathered during the study, before reflecting on the process of evaluation of user acceptance in clinical contexts. Through analysis of the trial's data, Chapter 6 provided a practical example showing how the longitudinal measurement approach could inform the technology design. Particularly, it identifies a set of implications for designing self-monitoring clinical interventions on smartwatch. Finally, drawing on the findings, this chapter discusses the challenges of conducting user acceptance research in clinical settings, in terms of alignment with existing acceptance models and the emergence of new perspectives, and a reflection on the measurement methods and on the conduct of such research in clinical settings.

Chapter 7 — Discussion

This chapter concludes with the contributions brought by this thesis. It first revisits the research questions and reflects on the contributions of this thesis. Then, it examines perspectives overlapping with user acceptance. Finally, this chapter concludes by calling for future research aiming to revise and advance the theoretical frameworks on user acceptance, design for user trajectories towards acceptance of health and wellbeing technologies, and adopt longitudinal approaches to the investigation of user acceptance within a human-centred design process.

Chapter 8 — Conclusion

This final chapter restates the contributions of this thesis to the field of Human-Computer Interaction.

Chapter 2

Literature Review

User acceptance of health and mental health technologies is a complex, multi-faceted notion. In this chapter, we decompose this concept, and examine the following aspects. First, we review the theoretical landscape associated with health and mental health technologies, including approaches to design and to validate such systems. Then, we describe the concept of temporality in Human-Computer Interaction and associated theories. Finally, we examine the theoretical landscape on user acceptance, including terminology, definitions, models, design and evaluation methods. These subjects are fundamentally interdisciplinary, combining elements from the fields of human-computer interaction, psychology, sociology, health, and mental health. We highlight the gaps in existing literature, and potential opportunities. This chapter therefore contributes to answering the first Research Question¹.

2.1 Technologies for Health & Mental Health Care

Over the last forty years, the domain of health technology — also referred to as digital health, e-health, tele-care, health/medical informatics — has grown exponentially. More recently, technological advances, such as machine learning and embedded sensors, opened a multitude of possibilities to improve health and mental health care. This section looks into existing approaches for the design of health and mental health technologies, and their clinical validation.

2.1.1 Design Approaches

The field of digital health and mental health care constitutes a complex design space. Target users — people experiencing health and/or mental health difficulties — are considered vulnerable, and their data sensitive. In addition, although patients or service users are often the primary user group of health and mental health technologies, other stakeholders, such as healthcare professionals and caregivers, are likely to be involved in

¹RQ1: How is user acceptance of health and mental health technologies defined, discussed, designed for, and measured, both in theory and in practice?

use of the technology. Furthermore, the context of usage of health and mental health technologies varies, ranging from clinical settings (e.g. hospital), through care settings (e.g. nursing homes), to personal settings (e.g. a person's home). These different elements contribute to shaping the design space with particular constraints. Guidelines for the design of health technologies have been published, with one of the first recommendations proposed by Jimison and Sher (Jimison & Sher, 1995, p. 789):

- Intuitive interface — (i) graphical metaphors easily understood by the general populace, (ii) design for use by naive, untrained users, (iii) online help available at every stage, (iv) immediate word definitions available in every application.
- Complete — contains information on all diseases and health concerns.
- Hierarchical presentation — (i) simple summary information presented first, (ii) more details and complexity available as desired, (iii) guided movement through databases, (iv) anticipate user requests, pre-search to improve speed.
- Presentation tailored to the individual — (i) present material appropriate for the assessed reading level, (ii) present material in the appropriate language, (iii) tailored material to history and assessed patient-specific health risks, (iv) incorporate patient preferences.
- Facilitate quality decision-making — (i) health outcomes information, (ii) incorporation of patient preferences on health outcomes, (iii) summary of tailored decision support information.
- Hard copy printout.

While a strand of the digital health literature has focused on designing management-oriented solutions — privileging objective outcomes such as cost savings — research in Computer Supported Cooperative Work (CSCW) focused on healthcare has tended to adopt a design approach starting from the reality of healthcare services (Fitzpatrick & Ellingsen, 2013), with an “emphasis on ‘support’ rather than ‘replacement’ and ‘transparency’ rather than ‘self-sufficient automatons’” (Berg, 1999, p. 391). In their review of 25 years of CSCW research, Fitzpatrick and Ellingsen highlighted the important contribution of the CSCW community to “understanding how healthcare work is collaboratively achieved in everyday practice and to design systems that may support the collaborative practices in healthcare” (Fitzpatrick & Ellingsen, 2013, p. 8).

Placing individuals' needs at the core of the design process is the focus of many design approaches. Most are grounded in User-Centred Design.

User-Centred Design

User-Centred Design (UCD) is an iterative design approach promoting the active involvement of users in the process of design to improve the understanding of their needs and requirements (Mao, Vredenburg, Smith, & Carey, 2005). UCD was theorised by Norman in 1988 as “a philosophy based on the needs and interests of the user, with an emphasis on making products usable and understandable” (Norman, 1988, p. 188). In the same work were published Norman's seven principles for facilitating the design process. Since then, UCD has been applied in various manners and contexts, while keeping engagement of users as a central aspect. A

standardised framework for human-centred design was created (and is regularly updated) by the International Organization for Standardization (ISO), proposing the following principles: (i) the design is based upon an explicit, understanding of users, tasks and environments, (ii) users are involved throughout design and development, (iii) the design is driven and refined by user-centred evaluation, (iv) the process is iterative, (v) the design addresses the whole user experience, and (vi) the design team includes multidisciplinary skills and perspectives (International Organization for Standardization (ISO), 2019).

In the healthcare domain, applications of UCD include for instance the prominent work of De Vito Dabbs and colleagues, on a self-monitoring device for lung transplant patients (De Vito Dabbs et al., 2009). Drawing on previously published principles (International Organization for Standardization (ISO), 2019; Gould & Lewis, 1985; Mantel, 1994), the authors developed the following approach to user-centred design: (i) gather an interdisciplinary team, (ii) assess users' comorbidities, (iii) recruit representative users (purposive sampling), (iv) assess how users currently perform the intended tasks, (v) run lab usability tests on each design iteration, (vi) conduct a field study on feasibility and usage, (vii) collect users final feedback in the lab.

In comparison to the digital health field, the domain of technologies for mental health care is shaped by different constraints, emerging from the particular vulnerability of users, the existing dynamic between patient and clinician, the types of technologies involved, and their integration in mental health care services. Doherty and colleagues developed guidelines to address these elements in design (G. Doherty, Coyle, & Matthews, 2010, pp. 246-249):

- Design for the client user — (i) design for client engagement, (ii) consider the social and cultural background of the client, (iii) consider clients with learning difficulties, and (iv) leverage technology familiar to clients.
- Design for the therapist user — (i) build on existing skills, experience, working methods and values of therapist, (ii) do not place burdensome time demands on therapists, and (iii) consider the responsibilities placed on therapists.
- Consider the dynamic of client and therapist together.
- Consider the requirements and traditions of mental healthcare settings — (i) adhere to international and local ethical requirements, (ii) build on accepted theoretical models of mental health care, and (iii) make it clear that data is secure.
- Make the system adaptable and sustainable.
- Provide flexibility in the delivery of support.
- Make the system tangible.

In reaction to an increasing trend in technologies to quantify and medicalize people's lives — namely the 'quantified self' movement (Shin & Biocca, 2017) — a strand of user-centred research developed, arguing for a humanistic design philosophy in which "a person is not medicalized, nor defined by others in terms of their experiences of (mental) health" (Møller & Kettley, 2017, p. 36). Looking at the case of wearable health devices, and drawing on Cunningham's framework on the relations between maker, wearer, and viewer (Cunningham,

2008), Møller and Kettley suggested the adoption of a relational design approach that accounts for the role of wearable health technology as “an object that affects the wearer physically, psychologically and socially” (Møller & Kettley, 2017, p. 47).

Drawing on User-Centred Design research, other design approaches have attempted to shape practices for the design of health and mental health technologies.

Participatory (Cooperative) Design

The participatory design approach was born in Scandinavia (Abrams, Maloney-Krichmar, & Preece, 2004) and reflects an “unswerving commitment to the direct involvement of users in designing their own experiences” (Bate & Robert, 2007, p. 19), and therefore in the design process. Techniques to involve users in the process of design include (but are not limited to) workshops, focus groups, interviews, and questionnaires. Although the adoption of participatory design for healthcare technologies was at first slow (Sjöberg & Timpka, 1998), this approach has been increasingly explored. A review by Bevan Jones et al. on the use of co-design for the development of mental health technologies with children and young people reflects this increasing trend (Bevan Jones et al., 2020). More recently, Papoutsis et al. called for a shift “from co-designing with technology users to co-designing with patients as service users, and with healthcare staff as professionals” (Papoutsis, Wherton, Shaw, Morrison, & Greenhalgh, 2021, p. 291), and proposed the following set of principles:

- Co-design needs to be anchored in articulated and emerging needs of both direct and indirect users, and of those who will be affected by the technology in different ways.
- Ongoing co-design in complex systems does not mean unplanned and haphazard efforts, but rather requires adaptive capability to recognize emergence and manage unpredictability.
- Healthcare staff need support to accommodate ongoing co-design of a “perpetual beta” mode for technology in the service (so that when technical glitches happen, they are not perceived as unprofessional on their part).
- Adequate resourcing and infrastructures need to be in place to enable co-design to reach its full potential.

Acknowledging the potential burdens placed on patients and carers, and significant changes sometimes required by health technologies, the authors argued for “negotiating underpinning values and standards built into new models of technology-supported care, as well as engaging staff and patients in co-shaping pathways, routines and shared visions” (Papoutsis et al., 2021, p. 291), building a strong case for participatory design in this context.

Value-Sensitive Design

Value sensitive design is an approach that aims to “account for human values in a principled and comprehensive manner throughout the design process” (Friedman, Kahn, Borning, & Hultdgren, 2013, p. 9). This concept opposes the notion that technologies are morally neutral, and holds that they embody values — promoting or

demoting specific moral values and norms (Nissenbaum, 2001; Brey, 2010). Friedman and colleagues described human values often implicated in system design as including “human welfare, ownership and property, privacy, freedom from bias, universal usability, trust, autonomy, informed consent, accountability, courtesy, identity, calmness, and environmental sustainability” (Friedman et al., 2013, p. 78). Health and mental health technologies are particularly prone to ethical questions, on issues including targeted behavioural change, accessibility, inclusiveness, personal data processing and sharing, privacy protection, etc. Value-sensitive design is an approach of interest for the design of health technologies, as evidence showed it supports “pro-active integration of ethical reflection in the stage of design of architectures, requirements, specifications, standards, protocols, incentive structures, and institutional arrangements” (Van den Hoven, 2007, p. 70). Drawing on this, Van Wynsberghe published the care-centred value-sensitive design framework, “using care values as the foundational values to be integrated into a technology and using the elements in care, from the care ethics perspective, as the normative criteria” (Van Wynsberghe, 2013, p. 431). The author defined the fundamental care values as *attentiveness*, *responsibility*, *competence* and *reciprocity*. The framework looks into five aspects, including *context* of use of the technology (e.g. hospital, home), *practice* (i.e. service provided), *actors involved* (e.g. patient, nurse), *type of technology* (e.g. assistive, enabling), and *manifestation of moral elements* (e.g. attentiveness).

Research also showed that values sometimes conflict in the healthcare domain — where for instance the values of “physical health, emotional well-being, and creativity” can conflict with the values of “privacy, civil rights, trust, and security” (Friedman et al., 2013, p. 67) — which may render complex the application of this design approach in practice.

Persuasive Design

An approach gaining interest for the development of health technologies is *persuasive design*. Persuasive systems, situated at the confluence of informatics, psychology and sociology, were defined by Fogg as “interactive technolog[ies] that change a person’s attitudes or behaviors” (Fogg, 1998, p.225). A decade later, the author published the Fogg Behavior Model for persuasive design, describing human behaviour as a product of three factors: *motivation*, *ability* and *triggers* (Fogg, 2009). In the context of health technologies, persuasive design addresses the longstanding issues of uptake and intervention compliance, and has been referred to as “all technological intervention components, which help people to take, regularly use and re-take (after relapses into unwanted behavior) interventions” (Baumeister, Kraft, Baumeister, Pryss, & Messner, 2019, p. 261). Methods of persuasion as described in (Grimes & Grinter, 2007) include: (i) *attitudinal advocacy*, or how engaging in a behaviour can change one’s attitude (Chaiken, Wood, & Eagly, 1996), (ii) *persuasion through messages*, or how messages expressed by others can impact one’s behaviour (Chaiken et al., 1996), and (iii) *issue framing*, how emphasising certain aspects of an issue more than others can affect one’s behaviour (Wood, 2000). A practical example is the reward of positive behaviours, for instance with “meaningful messages, attractive visuals or points in gaming system” (Ananthanarayan & Siek, 2012, p. 236). Moreover, the work of Grimes

and Grinter on health technology for low-income African American communities highlighted the importance of integrating cultural tailoring in the design of persuasive interventions (Grimes & Grinter, 2007).

There has been debate on the clarity of the correlation between the use of this design approach, and health-related behaviour change in users (Baumeister et al., 2019). For instance, on one hand, a review by Hamari et al. drew a mixed picture of the efficiency of persuasive design on user behaviour change, with only 54% studies reporting positive results (Hamari, Koivisto, & Pakkanen, 2014). On the other hand, a more recent review by Orji and Moffatt showed that a majority of the persuasive health technologies studied (75%) positively impacted user behaviour change (Orji & Moffatt, 2018). Considering the existence of publication bias in HCI research — due to the use of statistical significance as a major criterion for publishing studies (Dragicevic, 2016) — caution is needed when interpreting these results.

Somaesthetic Interaction Design

Somaesthetic interaction design (also referred to as soma design) is an approach drawing on *somaesthetics* (Shusterman, 2008), described by Höök and colleagues as “a way to examine and improve on all connections between sensation, feeling, emotion, and subjective understanding and values — in short: improving on our somas” (Höök et al., 2019, p. 2). In soma design, the digital side and the human side of an interaction combine to form “the interactive aesthetic experience” (Höök et al., 2019, p. 2). This process is argued to be both an interaction with *digital* and *physical* materials, and with the users’ *soma*: “our bodies and our subjective experiences, feelings, values, meaning-making, and movement-based engagements are altered by the design process” (Höök et al., 2019, p. 2). Rejecting the “dichotomy between body and mind” (Felice, Søndergaard, & Balaam, 2021, p. 410), and relying on interactions through the body and its movements (Søndergaard, Ciolfi Felice, & Balaam, 2021; Søndergaard et al., 2021; Campo Woytuk, 2019), this approach shows potential for the design of health and mental health technology-supported interventions. Design opportunities include for example movement rehabilitation, emotion regulation for management of stress/anxiety, mindfulness practice, and elderly home-care (Windlin, 2020; Höök et al., 2018). Finally, a recent strand of work explored the use of biosensing in soma design, which may find a range of applications in healthcare for its potential to monitor users’ health and mental health, and support users’ self-awareness and behavioural change (Alfaras et al., 2020; Tsaknaki et al., 2020).

Existing Challenges & Opportunities

Successfully engaging end-users in the process to design health and mental health care technologies faces longstanding challenges. While UCD and related design approaches strongly rely on an iterative process, the repeated involvement of target users is often difficult for multiple reasons. Firstly, working with vulnerable users groups on sensitive topics raises ethical concerns (Sanches et al., 2019a), which need to be identified and addressed before carrying out design activities, in order to safeguard participants from harm (e.g. by setting up a risk management procedure). Secondly, complex logistics can impede the conduct of iterative

collaborative design; these include time constraints for obtaining regulatory approvals (Bradford, Cashion, Condon, Rumble, & Bowers, 2021), difficulty in recruiting certain user groups (Fekete & Lucero, 2019; Bradford et al., 2021), sometimes requiring a change of recruitment strategy (Martin-Hammond, Vemireddy, & Rao, 2018). Involving end-users might also prove more challenging at design stage, than once the technology is deployed (E. L. Hsu, Elliott, Ishii, Sawai, & Katagiri, 2020). Users' mobility difficulties and comorbidities, as well as the need for the presence of caregivers during design sessions (for instance to accompany an elderly group) might also greatly impact the possibility of individuals participating in multiple design iterations (Willems, Vermeulen, van Haastregt, & Zijlstra, 2021; Årsand & Demiris, 2008; Barrett & Kirk, 2000). Finally, healthcare professionals' limited availability and difficult working conditions (G. Doherty et al., 2010) render challenging the inclusion of this user group in the process of design. The impact of these barriers can be observed in Fitzpatrick and Ellingsen review of CSCW literature; reflecting on the large number of papers that suggest design guidelines for healthcare systems, the authors comment:

« Only rarely however are those implications taken through to the actual design and deployment of prototype systems, and those that have been undertaken ... tend to be relatively small scale and of short duration. » (Fitzpatrick & Ellingsen, 2013, p. 31)

In addition to the complex design space, Morita and Cafazzo described three paradoxes likely to affect users' experience (Morita & Cafazzo, 2016). First, the *paradox of expertise*, which originates from only involving expert users in the design process, risking that the “health technology being developed reflects only the interactions and constraints of a small percentage of the total users” (Morita & Cafazzo, 2016, p. 2). Second, the *paradox of preference versus performance*, addressing the trade-off that occurs when tailoring interventions to users' preferences “sometimes at the expense of the system's usability” (Morita & Cafazzo, 2016, p. 4). Finally, the *paradox of choice*, drawing on a ‘less is more’ approach, and highlighting that healthcare professionals often work under extreme pressure, “which is a perfect situation for excessive choices to become overwhelming and a nuisance at a minimum, and safety hazard at its worst” (Morita & Cafazzo, 2016, p. 5). This stance aligns with Doherty et al.'s guidelines on *design for the therapist user* (G. Doherty et al., 2010).

Furthermore, particularly essential to the design of health and mental health technologies is adopting an approach that is fair, inclusive, and which results in a solution that does not harm users. Extensive evidence has revealed the dangerous — sometimes life-threatening — consequences of discriminatory design of health technologies on the life of users (Costanza-Chock, 2018). Discrimination in design is a multi-faceted problem, which finds its roots in the lower access and exclusion of certain communities from the process of design, a lack of diversity in digital health leadership, and harmful stereotypes. Discriminatory design can result, for instance, in misdiagnosed users (e.g. for the same symptoms, a chatbot diagnosed a man with heart attack, and misdiagnosed a woman with depression (Trendall, 2019)), no access to treatment (e.g. online therapy impossible for people living in an unsafe environment (Rodekirchen & Phinney, 2021), inaccessible technology (e.g. 95% of reviewed apps for anxiety with no accessibility features (Balaskas, Schueller, Cox, & Doherty, 2021))), under-represented groups of users (e.g. fitness apps ignoring user diversity, depicting White,

thin, young middle-class women (Doshi, 2018)), encouraged sexism (e.g. fertility apps advising which day to conceive to have a boy or a girl (*Baby Today?*, 2021)), negated users' identities (e.g. language failing to distinguish sex and gender, harming transgender, non-binary, and intersex people (Morgenroth & Ryan, 2020)), and the perpetuation of stereotypes (e.g. fatherhood apps portraying men as uneducated and uninterested in infant care (Thomas, Lupton, & Pedersen, 2018)). While recognising the important shift in design practice provided by approaches like value-sensitive design, Costanza-Chock highlighted in their book that *design justice* “seeks more than ‘freedom from bias’” (Costanza-Chock, 2018, p. 48). In a 2021 review, Figueroa and colleagues called for using *feminist intersectionality* to examine how gender intersects with other factors — race, ethnicity, sexual orientation, socio-economic status, geographic location — creating health disparities, in order to understand “how to design and disseminate digital health to achieve health equity” (Figueroa, Luo, Aguilera, & Lyles, 2021, p. 531).

2.1.2 Clinical Validation

While HCI techniques and design research can help explore user needs, clinical constraints, and the design space of health and mental health technologies, it is only by evaluating these systems with people with real health and/or mental health difficulties that many questions relating to design can be answered. In this section, we describe the main trends in the conduct of clinical trials assessing health and mental health care technologies.

User Group

People receiving health or mental health care are the primarily involved user group in validation studies. More often than not, validation of health technologies is conducted with adults. Particularly, mental health technologies are rarely clinically evaluated with children/adolescents (Sanches et al., 2019a); some examples include early work on mood diaries (Matthews & Doherty, 2011) and therapeutic computer games (Coyle, Matthews, Sharry, Nisbet, & Doherty, 2005). However, there are compelling reasons to address mental health problems in childhood and adolescence (Coyle, McGlade, Doherty, & O'Reilly, 2011), and good arguments for the use of technology with children and adolescents (Matthews & Doherty, 2011). Besides, we observe a lack of age diversity in user groups involved in the evaluation of technologies for health difficulties affecting humans of any age. For instance, clinical trials with children are prevalent when assessing technologies for asthma management (Bonini, 2017), but children are rarely involved in the validation of technologies for diabetes management (Holtz & Lauckner, 2012). The overall low number of clinical trials involving children/adolescents may reflect the additional practical and ethical difficulties of working with a highly vulnerable population, on a very sensitive topic. While healthcare professionals are often not the primary targeted user group, a small body of work addresses this population (Sanches et al., 2019a; Holtz & Lauckner, 2012). Finally, probably the least targeted user group is that of caregivers, with only very few clinical trials exploring the use of technology by, for instance, parents of children with health difficulties (Wangberg,

Årsand, & Andersson, 2006; Gammon et al., 2005; Iqbal et al., 2016; Fiks et al., 2016).

Form of Solution

The majority of clinical evaluations investigates health technologies that aim to directly support people experiencing health issues. In the mental health field, most clinical trials explore the use of technology for treatment (Sanches et al., 2019a), with some systems relying on evidence-based forms of treatment, such as cognitive behavioural therapy (Coyle et al., 2011; G. Doherty, Coyle, & Sharry, 2012; Schueller & Mohr, 2015) and acceptance commitment therapy (Langrial, Oinas-Kukkonen, Lappalainen, & Lappalainen, 2013). Coming second are self-management tools (Bardram et al., 2013; Matthews et al., 2015; Mohr et al., 2015; Frost, Doryab, Faurholt-Jepsen, Kessing, & Bardram, 2013); and finally, systems for diagnosis (Dibeklioglu, Hammal, Yang, & Cohn, 2015; Gruenerbl et al., 2014; Bhatia, Hayat, & Goecke, 2017). The large proportion of studies concerned with treatment interventions is encouraging. Yet, assessment and self-management are also an important part of day-to-day mental health practice, particularly for issues like bipolar disorder for which long-term self-management is a key feature (Matthews et al., 2015; Bardram et al., 2013).

In the health field, clinical trials mostly assess self-management tools (Bonini, 2017; Holtz & Lauckner, 2012). Other types of technologies found are systems for help-seeking (Fiks et al., 2016; Iqbal et al., 2016), and treatment (Koufopoulos, Conner, Gardner, & Kellar, 2016). Besides, some clinical studies explored the use of systems incorporating educational content (V. L. Franklin, Waller, Pagliari, & Greene, 2006; Frank, 2007; Wangberg et al., 2006; Rossi et al., 2009; Årsand, Tufano, Ralston, & Hjortdahl, 2008; Schneider et al., 2016; Merchant, Inamdar, & Quade, 2016).

Moreover, a small body of work addresses the analysis of corpora which might inform the development of tools for diagnosis or symptoms tracking (Bhatia et al., 2017; Dibeklioglu, Hammal, Yang, & Cohn, 2015).

Finally, a subset of clinical trials explores the use of novel technologies for health purposes, such as machine learning (Ortiz-Catalan et al., 2016; C. M. Martin et al., 2012; Burns et al., 2011), sensors (Merchant et al., 2016; myAirCoach Consortium, 2015; Van Sickle et al., 2016; Gruenerbl et al., 2014), games (Coyle et al., 2011; Heutinck, Jansen, van den Elzen, van der Pijl, & de Groot, 2018), and virtual reality (Seol et al., 2017; Heutinck et al., 2018). Particularly, we observe a growing body of work on the use of biofeedback — the visualisation of physiological variables. Biofeedback has been used as a component of emotion regulation interventions, for instance to reduce anxiety before public speaking (Azevedo et al., 2017), support recovery after stress exposure (Plans et al., 2019), or reduce risks of burnout (May et al., 2019). Biofeedback was also employed to tailor interventions, for example in systems using the detection of stress through heart and respiration to trigger a soothing intervention (Sarker et al., 2016). Finally, biofeedback was sometimes used to foster self-introspection, for instance in systems encouraging visualisation and reflection on heart rate variability to reduce Post-Traumatic Stress Disorder (Reyes, 2014).

Evaluation Methods

Situated at different stages of the technology lifecycle, studies investigating the use of technology for health and mental health purposes include (i) exploratory works — for instance evaluating prototypes (Coyle et al., 2011; Dauden Roquet, 2021; Valev, Leufkens, Sas, Westerink, & Dotsch, 2019) or deploying design probes (Campo Woytuk, Søndergaard, Ciolfi Felice, & Balaam, 2020) — (ii) pilot trials and feasibility studies (Rossi et al., 2009; Katz & Nordwall, 2008; Jannink et al., 2008; K. Doherty et al., 2019), and (iii) randomised controlled trials, focusing on validating effectiveness (Baeza-Barragán, Manzanares, Vergara, Casuso-Holgado, & Martín-Valero, 2020; Merchant et al., 2016; Richards et al., 2020, 2015).

In the mental health field, clinical studies aim to capture a range of outcomes, with the majority reporting a rich mixture of quantitative and qualitative data. Adherence (Matthews & Doherty, 2011; Schueller & Mohr, 2015; Mohr et al., 2015; Bardram et al., 2013) and usage (G. Doherty et al., 2012; Matthews & Doherty, 2011; Frost et al., 2013) are widely reported quantitative measures. Other measured outcomes included engagement (G. Doherty et al., 2012; Matthews & Doherty, 2011), usability (Mohr et al., 2015; Schueller & Mohr, 2015), satisfaction (Coyle et al., 2011), perceived benefit (Bardram et al., 2013), and clinical outcomes (Seol et al., 2017).

While only few clinical studies on mental health reported pre-post validated measures, the proportion is higher in trials assessing health technologies. For instance, across the studies on technologies for diabetes reviewed by Holtz and Lauckner, pre-post hemoglobin A1c was the most measured outcome (Holtz & Lauckner, 2012). In addition, reported measures in the health field are likely to include clinical outcomes (Baeza-Barragán et al., 2020; Faridi et al., 2008), disease severity (Matiz, Robbins-Milne, Krause, Peretz, & Rausch, 2016), self-efficacy (Faridi et al., 2008; V. L. Franklin et al., 2006), medication adherence (Johnson et al., 2016), usage (Ferrer-Roca, Cardenas, Diaz-Cardama, & Pulido, 2004; Kollmann, Riedl, Kastner, Schreier, & Ludvik, 2007), usability (Quinn et al., 2008; Hanauer, Wentzell, Laffel, & Laffel, 2009; Johnson et al., 2016; Greiner, Sawka, & Imison, 2015; Midaglia et al., 2019), satisfaction (A. E. Carroll, Marrero, & Downs, 2007; Ferrer-Roca et al., 2004; Gammon et al., 2005; Johnson et al., 2016; Cook, Modena, & Simon, 2016), and quality of life (Benhamou et al., 2007; Johnson et al., 2016). Studies including the delivery of educational post-study assessment might include measuring individuals' knowledge about illness and its management post-study (Rossi et al., 2009; V. L. Franklin et al., 2006). More rarely, some works will adopt a broader perspective, analysing the number of patient admissions post-intervention (Matiz et al., 2016).

Furthermore, it has been argued that healthcare technology research would greatly benefit from incorporating a qualitative component (Fitzpatrick & Ellingsen, 2013). Studies which report qualitative findings collected data through questionnaires (Cook et al., 2016; Fiks et al., 2016; Rossi et al., 2009), interviews (Carpenter, Geryk, Sage, Arrindell, & Sleath, 2016; Dauden Roquet, 2021; Gammon et al., 2005), focus groups (Fiks et al., 2016), self-documentation (Campo Woytuk et al., 2020). Issues discussed with respect to qualitative data include reasons for engagement (or non-engagement), comparisons to existing paper-based materials, comments on how the technology impacted on the person's treatment or lived experience, and requests for

additional functionality. The qualitative data might also relate to quantitative data, for example, in explaining the reasons behind different patterns of engagement.

Finally, the length of the studies varies widely, ranging from short lab studies (De Freitas et al., 2019), through short field studies (Masseti et al., 2018; Curran, Nichols, Xie, & Harper, 2010), to longer ones, for instance lasting over 20 weeks (Ferrer-Roca et al., 2004; Benhamou et al., 2007; V. Franklin, Greene, Waller, Greene, & Pagliari, 2008; Vähätalo, Virtamo, Viikari, & Rönnemaa, 2004; Istepanian et al., 2009; Matthews & Doherty, 2011).

Existing Challenges & Opportunities

Researchers looking into evaluating health and mental health technologies in clinical contexts face a range of challenges. The present section discusses these challenges, and reflects on potential opportunities. We structure this discussion in three parts: (i) working with clinical researchers, (ii) working with clinical interventions, and (iii) conducting clinical trials.

Working with Clinical Researchers. Health and mental health are unique and sensitive research settings, and researchers face a range of difficulties to conduct clinical evaluations likely reflects a range of difficulties. Conducting clinical evaluations of technologies for this purpose will require sustained collaboration with health and mental health researchers in most cases. While interdisciplinary collaboration is not uncommon within HCI, Blandford et al. (Blandford et al., 2018) discuss a number of important ways in which health and HCI research differs, ranging from research methods (literature review, development and evaluation practices all differ substantially) and ethical perspectives (preventing harm vs. individual rights), through to publication practices (long, exploratory papers in HCI vs. short but varied papers in health research).

Working with Clinical Interventions. As clinical research comes to consider how technology might be used in a wider range of treatments and therapies, there is an opportunity for HCI research to contribute in terms of understanding requirements and context, how people interact with technology, methods for ideation of novel solutions, and exploring the strengths and challenges associated with multiple different possible designs. Mobile health technologies, the proliferation of sensors, and the emergence of machine learning techniques have opened up many possibilities for the use of technology in health. These technologies are powerful but also potentially problematic, and so there is a need for exploration of all aspects of these technologies with real people before progressing to trials whose main purpose is establishing effectiveness.

Conducting Clinical Trials. The development of complex healthcare interventions has been described as a process with multiple stages of progression from modelling and exploratory trials through to randomised controlled trials and implementation studies (Campbell et al., 2000). While this is clearly applicable to the development of health interventions supported by technology, the long time-frame of this validation process is difficult to reconcile with the demands of rapidly and continually technology. Due to ethical issues around novel technologies, and access barriers to clinical settings (Matthews, Gay, & Doherty, 2014), we are not arguing that every novel design should be tested in clinical trials. But we contend that research in this area

should be more informed by the needs of real patients and have, as an ultimate goal, evidence-based design development — whether the resulting artefact is aimed to be used in or outside of clinical settings. In a world where technology development can never really stop, we should consider how we might incorporate HCI elements into clinical evaluation protocols, as well as during implementation. The advantage of doing so from a HCI perspective is the prospect of receiving detailed clinical outcome data and demographics, together with more familiar forms of data such as engagement and reports of user experience. Conversely, as a discipline we need to be able to clearly articulate and demonstrate what HCI has to offer, for example in terms of helping to achieve better engagement and thus enabling better science (Konrad et al., 2015; G. Doherty et al., 2012), or showing how HCI research can contribute to refining designs to improve effectiveness (Frost et al., 2013), as development of new interventions and accumulating an evidence base progresses. Ultimately, research in this area should leverage mutually beneficial collaborations between HCI, clinical psychology, and other relevant disciplines.

2.2 Temporality in Human-Computer Interaction

Within the third wave HCI (Bødker, 2015), the issue of temporality has received increased attention going beyond the traditional approach involving clock time, to target also the socio-cultural and existential aspects of time (Rapp, Odom, Pschetz, & Petrelli, 2021). The latter aspects have been mostly explored through the lens of user experience. Seminal here are Forlizzi and Battarbee’s framework of user experience (Forlizzi & Battarbee, 2004) emphasising the episodic quality of discrete experiences and their meaning, or the Wright and McCarthy’s technology as experience framework highlighting its felt-life quality (J. McCarthy & Wright, 2004). While such early work has inspired the growing interest on temporality aspects of user experience, it has been also critiqued for its focus on discrete events, failing to capture the temporal richness and complexity of users’ patterns of interaction with technology.

A related body of work from Science and Technology Studies relates to domestication theory (Silverstone & Hirsch, 1992) and its framework, also used in HCI (Sas, Davies, et al., 2020), that describes the process of long-term technology use and adoption, albeit not user experience per se. This framework discusses three stages of technology adoption: commodification which raises expectations of technology function and value before being used, appropriation where users integrate technology in their lives and practices as they appreciate its relevance, and conversion where users accept the technology to reflect self-identity and signal status. Building on domestication theory, subsequent work on temporal aspects of user experience is captured by Karapanos and colleagues’ framework of user experience over time (Karapanos, Zimmerman, Forlizzi, & Martens, 2009a). The authors argue for the importance of moving from the micro-temporal perspective of how “user experiences are formed, modified and stored” to a macro-temporal perspective of how they also change over time (Karapanos et al., 2009a, p. 730). Karapanos and colleagues explored user experience of iPhone, during 1 week before purchase and 4 weeks of use (Karapanos et al., 2009a). Their findings identified three phases of user experience, consisting of *orientation* capturing early experiences of excitement and learning to

use the technology, where ease of use was key, *incorporation* marked by increasing integration of technology in everyday lives due to usefulness and long-term usability, and *identification* marked by emotional attachment due to increased personal and social meaningfulness for self-identity and connectedness. These three phases are preceded by the stage of *anticipation*, reflecting users' a priori expectations.

Arguments have been further made that temporal richness can also be reflected through trajectories of contiguous interactions marked by continuity (Faconti & Massink, 2000) as they unfold over time rather than occurring merely at discrete moments (Huang & Stolterman, 2011). Limited work however has explored the trajectory approach to user experience, with a few exceptions such as Benford and Giannachi's framework capturing the chronology of events in mobile games both envisaged by designers i.e., canonical trajectories, and experienced by participants i.e., participant trajectories (Benford & Giannachi, 2008), which may differ from the former when users are given control over different choices while interacting with experience, with the record of the latter becoming historic trajectories (Benford & Giannachi, 2008). The concept of *interactional trajectory* also extends the traditional user journey "through a user experience" (Velt, Benford, & Reeves, 2017, p. 2093) to richer trajectories "over space and time [involving] multiple roles and interfaces" (Benford, Giannachi, Koleva, & Rodden, 2009, p. 717). Temporality in HCI has also been considered in speculative and futuring design, where the focus however has been on radically different alternatives of the futures underpinned by critical design (Kozubaev et al., 2020).

To conclude, the growing body of HCI research on temporality has been mostly at micro level or from the lens of situated, discrete user experiences, with much less work exploring the macro level approach to how user experiences change over time.

2.3 User Acceptance of Technology

While clinical effectiveness is critical to the success of digital health and mental health interventions, a lack of user acceptance will impede individuals' uptake and long-term use of the technology (Sekhon et al., 2017). Due to the longitudinal nature of healthcare, non-use and discontinued use of technology in this context could mean a lack of engagement with treatment, or inaccurate self-monitoring. *User acceptance*, defined in Chapter 3 as "individuals' perception of the technology, leading to its use or non-use", is therefore a major issue requiring consideration when developing health and mental health care technologies. This section reviews the theoretical landscape of user acceptance, featuring terminology, definitions, models, and measurement.

2.3.1 Terminology & Definitions

An evolving terminology and range of definitions can be found in the literature discussing technology acceptance. Terms such as *acceptability*, *acceptance*, and *adoption* are often employed, sometimes interchangeably. For instance, Al-Youssef referred to acceptability as *user willingness* to use a system (Al-Youssef, 2015), while

citing the definition of acceptance given in Dillon and Morris (Dillon & Morris, 1996). These terms were sometimes equated to other human-computer interaction (HCI) concepts such as *user satisfaction* (Fischer et al., 2016). Yet, a part of the literature tried to differentiate the process of technology acceptance from existing concepts. For instance, Schade and Schlag described *acceptability* as “a prospective judgement of measures to be introduced in the future” (Schade & Schlag, 2003, p. 47) which they detail as “the target group will not have experienced any of these measures”. Close to this interpretation, Adell equated *acceptance* to “the degree to which an individual intends to use a system and, when available, incorporates the system in [their activity]” (Adell, 2010, p. 31).

The Cambridge Dictionary defines *acceptability* as “the quality of being satisfactory and able to be agreed to or approved of” ([ACCEPTABILITY | meaning in the Cambridge English Dictionary, 2021](#)) and *acceptance* as a “general agreement that something is satisfactory or right” ([ACCEPTANCE | meaning in the Cambridge English Dictionary, 2021](#)). This suggests that *acceptability* is the quality of an object from the perspective of a stakeholder, whereas *acceptance* is more of a process relating to a stakeholder’s interaction with this object. In the context of HCI, it translates into a user-system dyad. In the same line, Proctor et al. defined *acceptability* as “the perception among implementation stakeholders that a given treatment, service, practice, or innovation is agreeable, palatable, or satisfactory” (Proctor et al., 2011, p. 67).

With the literature highlighting the importance of temporality in user experience research (Forlizzi & Battarbee, 2004; Hassenzahl & Tractinsky, 2006), some authors attempted to integrate a temporal dimension into the process of technology acceptance. In that respect, a group of authors supported the idea of a multi-stage process. Martin et al. and Distler et al. defined technology *acceptability* as one’s perception of a system before use (N. Martin et al., 2015; Distler et al., 2018). They distinguished it from *acceptance*, which they defined as the users’ perception of the system after use. Terrade et al. and Garces et al. went a step further, stating that acceptance referred to the *initial use* of a system in controlled settings (Terrade et al., 2009; Garces et al., 2016). In their Theoretical Framework on Acceptability (see Fig. 2.1), Sekhon and colleagues differentiated three stages, featuring *prospective acceptability* – prior to participating in the intervention – *concurrent acceptability* – whilst participating in the intervention – and *retrospective acceptability* – after participation in the intervention (Sekhon et al., 2017).

A slightly different approach is that of Somat et al. (Somat et al., 2012), who introduced the continuum *acceptability—acceptance—appropriation*, describing the “change in the subjective evaluation of a product before using it (*acceptability*), after having used it (*acceptance*) and once the product has been introduced into the user’s daily life (*appropriation*)” (Distler et al., 2018, p. 612). Other definitions of appropriation include “a process of social construction in which the actions and thoughts of the user are shaped by the technology, while the meaning and effects of the technology are shaped through the users’ actions” (Overdijk & Van Diggelen, 2006, p. 90) and “the process through which technology users go beyond mere adoption to make technology their own and to embed it within their social, economic, and political practices” (Bar, Weber, & Pisani, 2016, p. 617).

Whereas a consistent framework seemed to emerge from these definitions, another term, *adoption*, came

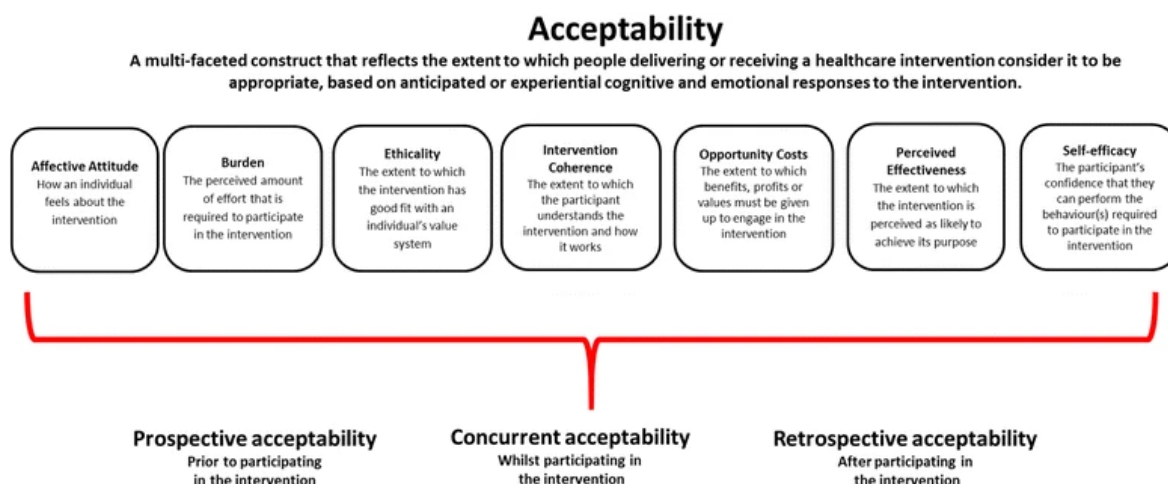


Figure 2.1: The theoretical framework of acceptability, Sekhon et al. (2017).

into the picture. Some authors such as Carroll et al. equated the process of *adoption* to a multi-phase process starting with “deciding to adopt (selecting, purchasing, or committing to use it) and then achieving persistent use” (J. Carroll, Howard, Peck, & Murphy, 2003, p. 38). In contrast, Karahanna et al. (Karahanna, Straub, & Chervany, 1999) described *pre-adoption* and *post-adoption* (continued use) stages, presenting *adoption* as an event allowing progress from one stage to the other. Similarly, Rogers defined *adoption* as the user’s decision to “make full use of an innovation as the best course of action available” (Rogers, 1983, p. 172).

To conclude, a number of definitions of user acceptance are available in the literature, several of which make important distinctions between the different stages of the process. Omitting that distinction in the terminology, and using the terms *acceptability*, *acceptance*, and *adoption* interchangeably can create ambiguities about what is actually being measured or discussed, making the understanding of research results difficult. This issue was highlighted in Sekhon et al.’s review, showing the confusion around the concept of technology acceptability in the healthcare literature (Sekhon et al., 2017). Finally, a review of definitions for digital health (Otto et al., 2018) stressed the importance of common terminology for interdisciplinary collaboration.

2.3.2 Technology Acceptance Models

For over three decades, research has explored the reasons behind users’ acceptance or rejection of technology (Salovaara et al., 2011). In this section, we review the models of technology acceptance which are considered validated — i.e. models exhibiting strong psychometric properties — and discuss significant shifts in the field.

The research area of user acceptance is situated at the intersection of the fields of HCI, psychology and sociology. The socio-psychological Theory of Reasoned Action (TRA) developed in 1975 by Fishbein and Ajzen (Fishbein & Ajzen, 1975) is particularly key to user acceptance research, for it supports the prediction of a wide range of behaviours. The TRA constitutes the basis of most models of technology acceptance, and includes the following constructs (also see Fig. 2.2):

- *behavioural intention*, or an individual’s intention to willingly perform the behaviour (Ajzen, 1985).

- *attitude*, or “the degree to which a person has a favorable or unfavorable evaluation of the behavior in question” (Ajzen & Madden, 1986, p. 454).
- *behavioural beliefs*, or “beliefs people hold about the object of the attitude” (Ajzen, 1985, p. 191).
- *outcome evaluation*, the “probability that the behavior will produce the outcome in question” (Ajzen, 1985, p. 191).
- *subjective norm* defined as “the perceived social pressure to perform or not to perform the behavior” (Ajzen & Madden, 1986, p. 454).
- *normative beliefs*, or “the likelihood that important referent individuals or groups approve or disapprove of performing a given behavior” (Ajzen & Madden, 1986, p. 455).
- *motivation to comply* with the referent in question.

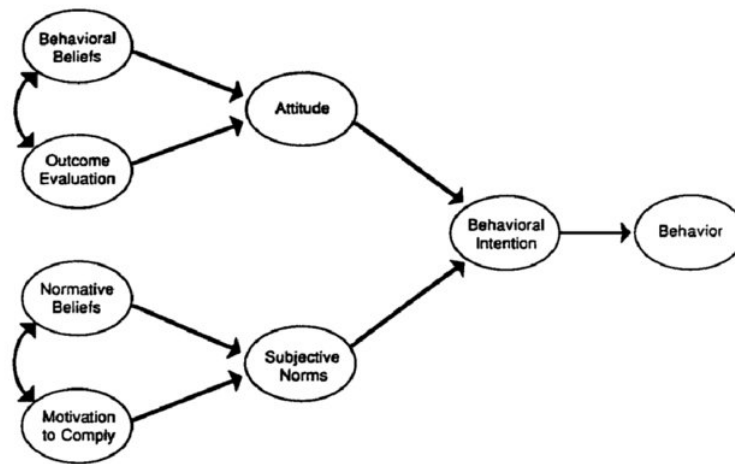


Figure 2.2: Theory of Reasoned Action, Fishbein and Ajzen (1975).

Acceptance models aim to explain individual acceptance of information technology. They share a basic conceptual framework (see Fig. 2.3), where the user’s *individual reactions to using technology* influence their *intention to use*, ultimately impacting their *actual use* of the system. The bidirectional relationship materialises how *actual use* of technology also affects user’s *individual reactions*, and therefore participates in shaping future use (or non-use) of the system.

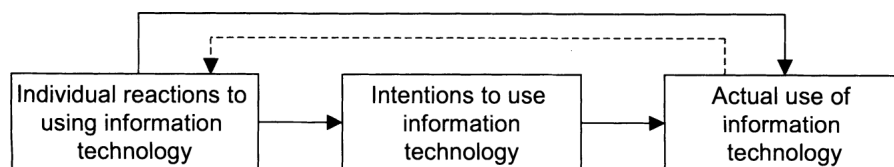


Figure 2.3: Basic conceptual framework underlying user acceptance models, Venkatesh et al. (2003).

Models for Technologies for the Workplace

Technological progress and the introduction of computers in the workplace influenced the early days of user acceptance research, with the first published models focusing on use of technology for work. One of the most influential acceptance models is the Technology Acceptance Model (TAM), published in 1985 by Davis

(F. Davis, 1986). The author argued that testing user acceptance of a system early in its development would have the most value, as it would “provide useful information about the relative likelihood of success [of technology]” (F. Davis, 1986, p. 2). The TAM was designed with this intent, and focuses on factors influencing individuals’ acceptance of technologies for the workplace.

The original model (see Fig. 2.4) presents three factors impacting individuals’ motivation to use a system:

- *perceived usefulness* defined as “the degree to which an individual believes that using a particular system would enhance [their] job performance” (F. Davis, 1986, p. 26).
- *perceived ease of use* defined as “the degree to which an individual believes that using a particular system would be free of physical and mental effort” (F. Davis, 1986, p. 26).
- *attitude toward using* defined as “an individual’s degree of evaluative affect toward the target behaviour” (Fishbein & Ajzen, 1975, p. 216).

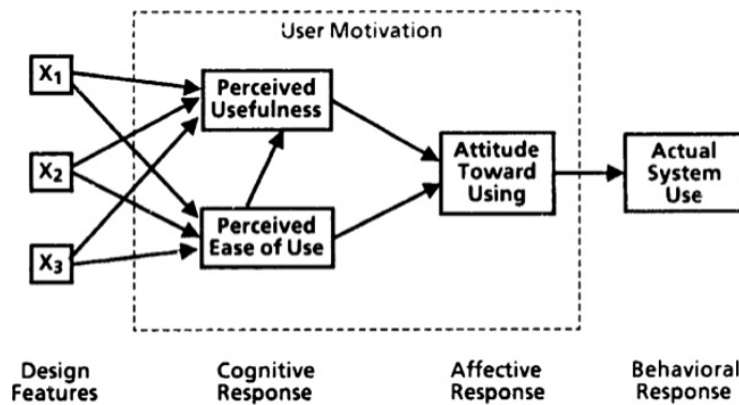


Figure 2.4: Technology of Acceptance Model, F. Davis (1986).

In subsequent work, Davis and colleagues integrated the TRA construct *behavioural intention* – “how hard people are willing to try ... in order to perform the behavior” (Ajzen, 1985, p. 181) – as a factor of technology acceptance (F. D. Davis et al., 1989), and adapted the TAM in consequence (see Fig. 2.5). This work suggested that acceptance research should also consider the TRA construct *subjective norm*.

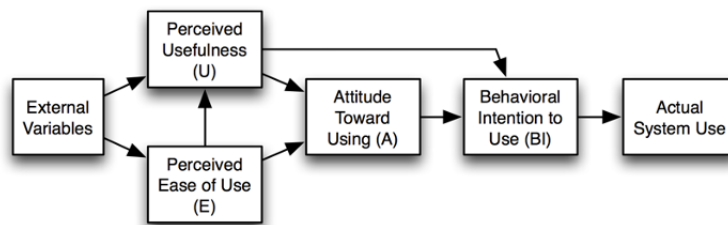


Figure 2.5: Technology Acceptance Model, F. D. Davis et al. (1989).

In the following years, researchers started examining the *external variables* construct uncovered in the TAM, also referred to as acceptance *determinants* or *antecedents*. This strand of research drew on the advances in the psychology field, and particularly the newly developed Theory of Planned Behaviour (TPB) (Ajzen, 1985). The TPB extended the TRA with a new construct, *perceived behavioural control*, referring to “the perceived ease or difficulty of performing the behavior” and integrating both past and anticipated

experiences (Ajzen, 1985, p. 188). In an attempt to clarify the relationships between one's set of beliefs and their behavioural intention, but also facilitate the operationalisation of the theory in user acceptance research, Taylor and Todd proposed the Decomposed Theory of Planned Behaviour model (see Fig. 2.6).

This new model incorporates constructs from the TRA, TPB, and literature on innovation adoption (Rogers, 1983; Tornatzky & Klein, 1982), including:

- *relative advantage* refers to “the degree to which an innovation is perceived as better than the idea it supersedes” (Rogers, 1983, p. 212).
- *complexity* represents “the degree to which an innovation is perceived as relatively difficult to understand and use” (Rogers, 1983, p. 242).
- *compatibility* is “the degree to which an innovation is perceived as compatible with [one's] existing values, past experiences, and needs” (Rogers, 1983, p. 224).
- *normative influences* i.e. persuasive social influences.
- *subjective norm* is “formed as the individual's normative belief concerning a particular referent weighted by the motivation to comply with that referent” (Taylor & Todd, 1995, p. 140).
- *efficacy*, an individual's confidence in their ability to perform a particular behaviour (Ajzen, 1985, p. 184).
- *facilitating conditions*, or “the availability of resources needed to engage in a behavior” (Taylor & Todd, 1995, p. 139).

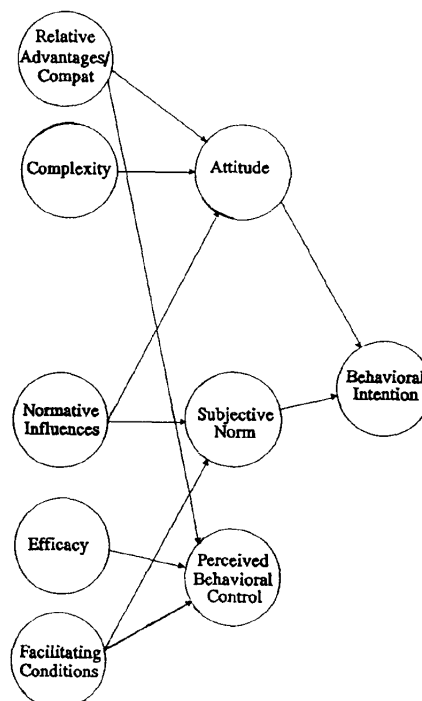


Figure 2.6: Decomposed Theory of Planned Behaviour, Taylor and Todd (1995).

Building on this body of work, Venkatesh and Davis proposed the TAM2 (Venkatesh & Davis, 2000). This extension of the TAM incorporates antecedents to the constructs of *perceived usefulness* (see Fig. 2.7):

- *subjective norm* previously defined.

- *image* defined as “the degree to which use of an innovation is perceived to enhance one’s image or status in one’s social system” (G. C. Moore & Benbasat, 1991, p. 195).
- *job relevance* defined as “an individual’s perception regarding the degree to which the target system is applicable to [their] job” (Venkatesh & Davis, 2000, p. 191).
- *output quality*, or “how well the system performs [required] tasks” (Venkatesh & Davis, 2000, p. 191).
- *result demonstrability* defined as “tangibility of the results of using the innovation” (G. C. Moore & Benbasat, 1991, p. 203).
- *experience* defined as the use of the target system (Venkatesh & Davis, 2000).
- *voluntariness* defined as “the extent to which potential adopters perceive the adoption decision to be non-mandatory ” (Venkatesh & Davis, 2000, p. 188).

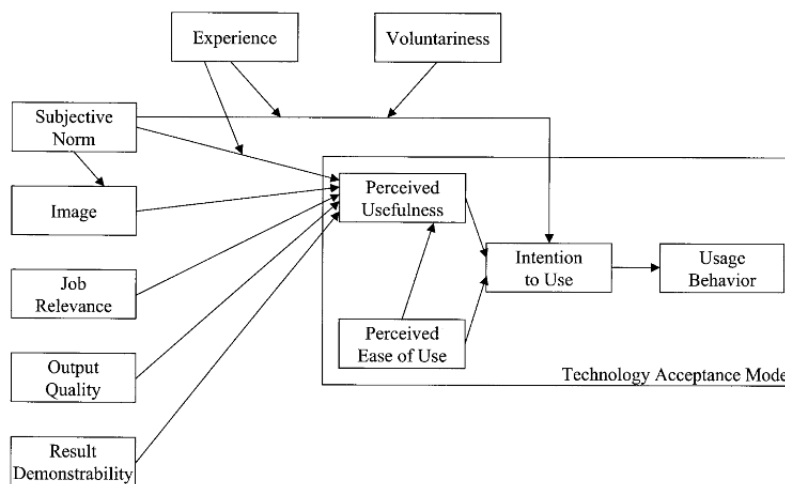


Figure 2.7: Technology Acceptance Model 2, Venkatesh and Davis (2000).

Venkatesh separately investigated antecedents to the construct of *perceived ease of use*. Doing so, the author revisited constructs uncovered by the TRA and TPB, distinguishing the notion of internal control (*computer self-efficacy*) from the perceptions of external control (*facilitating conditions*), and conceptualising intrinsic motivation as *computer playfulness*, and emotion as *computer anxiety*. This work gave birth to another extension of the TAM, named TAM2’ (see Fig. 2.8), and including:

- *computer self-efficacy* previously defined.
- *perceptions of external control*, or the perception of facilitating conditions to the use of the system (Venkatesh, 2000).
- *computer anxiety* defined as “the fear or apprehension felt by individuals ...when they considered the possibility of computer utilization” (Simonson, Maurer, Montag-Torardi, & Whitaker, 1987, p. 238).
- *computer playfulness* defined as “the degree of cognitive spontaneity in microcomputer interactions” (Webster & Martocchio, 1992, p. 204).
- *perceived enjoyment*, or “the extent to which the activity of using a specific system is perceived to be enjoyable in its own right” (Venkatesh, 2000, p. 351).
- *objective usability* allowing to “compare different systems using objective measures of usability/system

characteristics” (Venkatesh & Davis, 1996, p. 457).

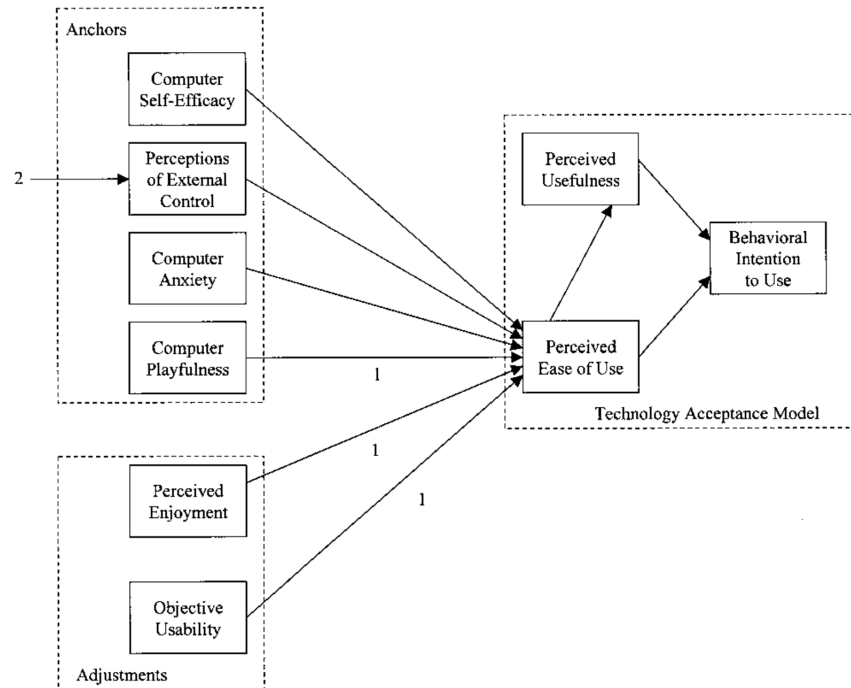


Figure 2.8: Technology Acceptance Model 2', Venkatesh (2000).

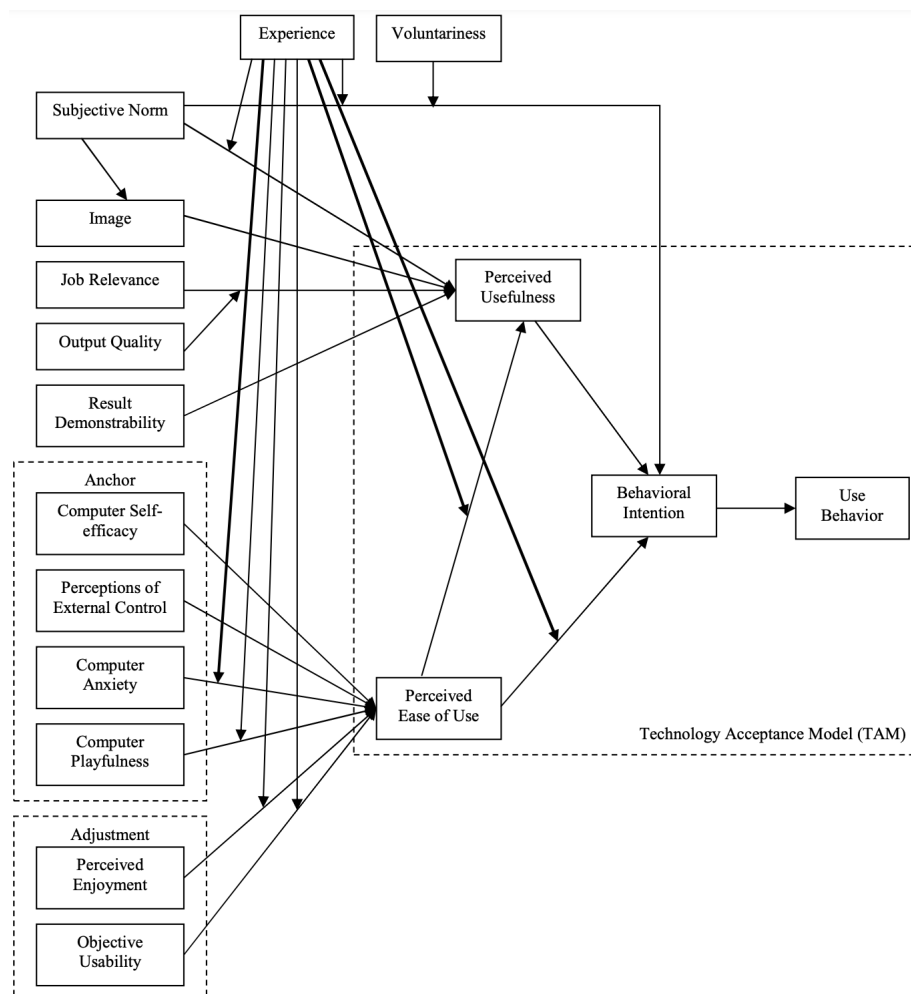


Figure 2.9: Technology Acceptance Model 3, Venkatesh and Bala (2008).

In an effort to assemble a “complete nomological network of the determinants of IT adoption and use” in the workplace (Venkatesh & Bala, 2008, p. 301), Venkatesh and Bala combined TAM2 and TAM2’ into a single model. The new TAM3 introduced additional relationships between antecedents to *perceived usefulness* and *perceived ease of use* (see Fig. 2.9).

Acknowledging the growing number of models developed, a strand of the literature has focused on unifying the theoretical frameworks of user acceptance. Reviewing the similarities and differences across previously developed acceptance models through a large longitudinal study, Venkatesh and colleagues (Venkatesh et al., 2003) formulated the Unified Theory of Acceptance and Use of Technology (UTAUT).

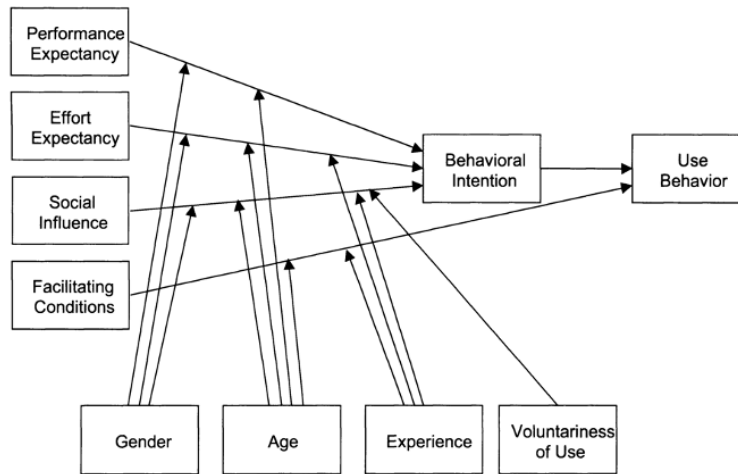


Figure 2.10: Unified Theory of Acceptance and Use of Technology, Venkatesh et al. (2003).

This model (see Fig. 2.10), aiming to explain employee technology acceptance, comprises the following constructs:

- *performance expectancy* is defined as “the degree to which an individual believes that using the system will help [them] to attain gains in job performance” (Venkatesh et al., 2003, p. 447).
- *effort expectancy*, “degree of ease associated with the use of the system” (Venkatesh et al., 2003, p. 450).
- *social influence* is defined as “the degree to which an individual perceives that important others believe [they] should use the new system” (Venkatesh et al., 2003, p. 451).
- *facilitating conditions* previously defined.
- *gender*.
- *age*.
- *experience* previously defined.
- *voluntariness of use* previously defined.

Models for Pervasive Technologies

While this first body of work focused on acceptance of technology in a work context, in the early 2000s acceptance research started to explore a wider range of technological contexts. For instance, a study by Koufaris looking at the case of online shopping (Koufaris, 2002) argued that users’ emotional response to

a technology impacts their future use. This research aligned with previously uncovered constructs (e.g. *perceived enjoyment*, TAM2'), and confirmed a theoretical shift from a vision of information systems as 'purely utilitarian' to potential providers of enjoyable experiences. Consequently, previously developed models, like the UTAUT, were extended/adapted for use in new contexts, such as health information system (Chang, Hwang, Hung, & Li, 2007). These new models also explored different user populations (e.g. healthcare professionals (Mun, Jackson, Park, & Probst, 2006)) and cultural settings so far under-considered (e.g. India (Gupta, Dasgupta, & Gupta, 2008)). Venkatesh et al. argued that, although these adaptations have been "helpful to expand the theoretical horizons of UTAUT" (Venkatesh et al., 2012, p. 160), they were not necessarily supported by theoretical evidence. In an effort to make the UTAUT more largely applicable, the authors proposed a revised version (see Fig. 2.11), the UTAUT2 (Venkatesh et al., 2012).

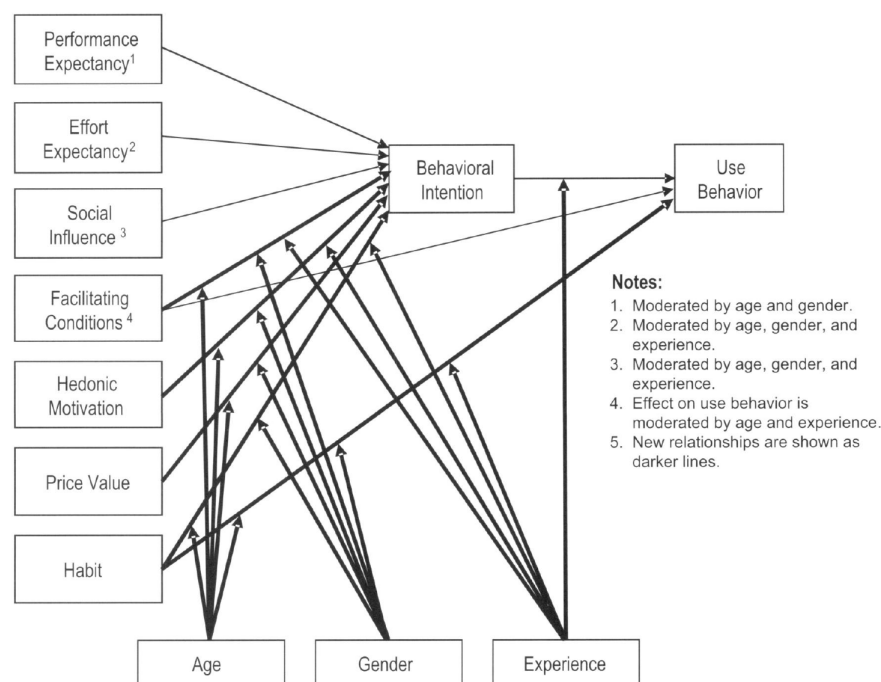


Figure 2.11: Unified Theory of Acceptance and Use of Technology 2, Venkatesh et al. (2012).

Described as a model of consumer acceptance and use of technology, the UTAUT2 drops constructs highly particular to the use of systems for work (e.g. *voluntariness to use*), and incorporates the following factors:

- *performance expectancy* previously defined.
- *effort expectancy* previously defined.
- *social influence* previously defined.
- *facilitating conditions* previously defined.
- *hedonic motivation*, or the fun/pleasure derived from using a technology (Brown & Venkatesh, 2005).
- *price value*, consumers' cognitive tradeoff between the perceived benefits of the applications and the cost for using them (Venkatesh et al., 2012).
- *habit*, a construct that "reflects the results of prior experiences" (Venkatesh et al., 2012, p. 161).
- *age*.

- *gender*.
- *experience* previously defined.

Within the body of work investigating acceptance of technologies for everyday life, Connelly proposed the Pervasive Technology Acceptance Model (PTAM) (Connelly, 2007), validated by a later study (Mohd, Ahmad, Samsudin, & Sudin, 2010). The author stressed that “people of all ages, from all walks of life will interact with the technology”, which further supports the argument for ensuring sample diversity when evaluating user acceptance. The PTAM introduces the factor of *integration*, defined as “how well the technology is integrated into our lives” (Connelly, 2007, p. 4).

Models for Healthcare Technologies

As digital innovation also gained traction in the healthcare context, user acceptance theories evolved accordingly, with the publication of new models. For instance, Kim and Park’s Health Information Technology Acceptance Model (HITAM) (Kim & Park, 2012). The HITAM (see Fig. 2.12) regrouped previously uncovered factors of acceptance into three categories: health, information, and technology. The model also introduced a new mediator, *perceived health threat*, with two antecedents: *health status* refers to whether the individual lives with “any diseases or comorbidity” (Kim & Park, 2012, p. 3), and *health belief and concerns* is associated with perceived susceptibility and issue severity (Hochbaum, Rosenstock, & Kegels, 1952).

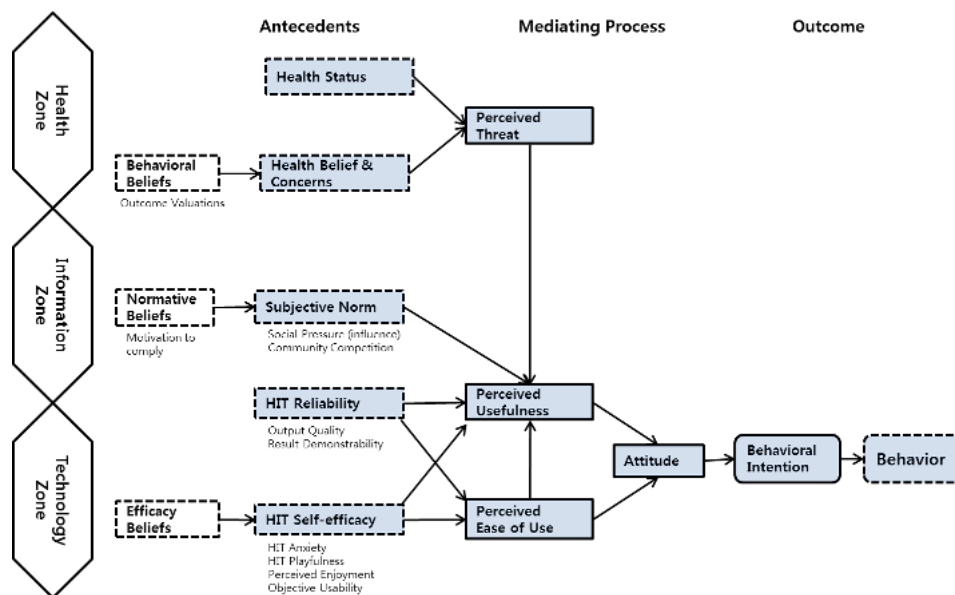


Figure 2.12: Health Information Technology Acceptance Model, Kim and Park (2012).

Further building on this work and psychology theories such as the Health Belief Model (Hochbaum et al., 1952), Dou et al. published a model of patient acceptance (see Fig. 2.13) integrating the constructs *resistance to change* defined as “people’s attempt to maintain their previous behaviors and habits in the face of change required” (Dou et al., 2017, p. 3), and *relationship with doctor*.

More recently, a body of work established the impact of *privacy concerns* — defined as “concern for loss of privacy and need for protection against uncalled-for communication and misuse of personal information” (Dhagarra et al., 2020, p. 3) — on user acceptance (C.-L. Hsu et al., 2013; Dhagarra et al., 2020; Schomakers et al., 2019).

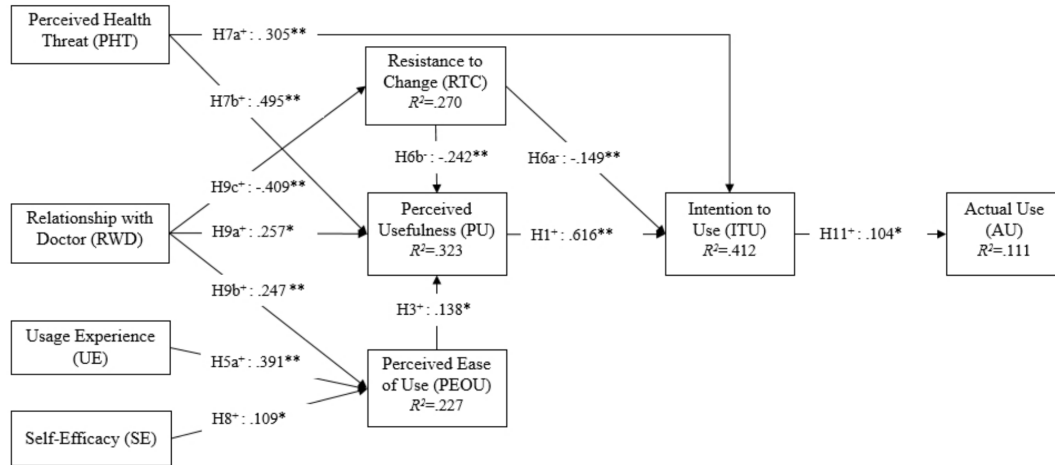


Figure 2.13: Model for patients' acceptance of smartphone health technology for chronic disease management, Dou et al. (2017).

Other related factors like *perceived security* and *information security literacy* were also considered (C.-L. Hsu et al., 2013). Finally, Dhagarra et al. examined the notion of *trust* (see Fig. 2.14), described as an individual's belief that the healthcare provider will fulfil their needs (Dhagarra et al., 2020, p. 4), and findings revealed its influence on user acceptance of healthcare technology.

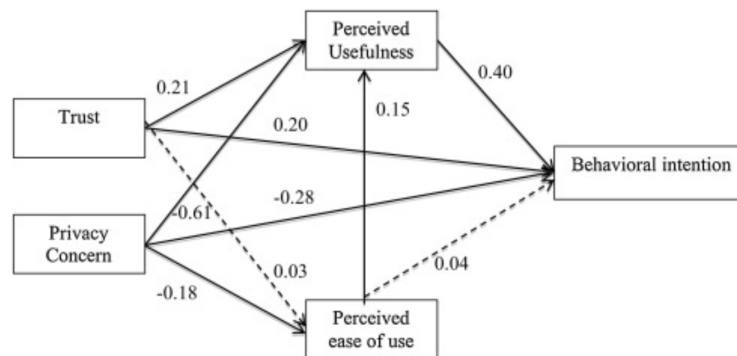


Figure 2.14: Model for patient acceptance of technology in healthcare services, Dhagarra et al. (2020).

We notice a trend in this recent strand of research to produce models focusing on particular areas of concerns for user acceptance of health technologies. While there is value in theoretical models encompassing a wide range of evidence-based acceptance factors, the publication of models presenting a concise set of factors might provide better guidance for user acceptance research in specific human and technological contexts. However, the wide range of models of user acceptance published so far, and the inconsistent inclusion of validated acceptance factors risk making the field difficult to navigate, and the operationalisation of theory in design and research practice complex. In addition, despite the body of work supporting the consideration of user acceptance as a multi-stage process (Sekhon et al., 2017; N. Martin et al., 2015; Distler et al., 2018;

Terrade et al., 2009; Garces et al., 2016; Somat et al., 2012; Rogers, 1983), temporality is absent from the validated models of acceptance.

2.3.3 Design Approaches

Despite the rich set of user acceptance theories previously described, attempts to address the concept at design stage often consider a small subset of acceptance factors present in validated models. Among these, *perceived usefulness* and *perceived ease of use* are the most addressed in design practices. Wartena and Dijk stated “design for acceptance is in its essence a practical approach to multicriteria optimisation problem of the *perceived usefulness* and *perceived ease of use* of the principal stakeholders” (Wartena & van Dijk, 2013, p. 54). The authors described their iterative approach to design for acceptance of a therapeutic game: (i) exploring the design space — i.e. gathering a set of evidence-based interventions and potential designs — (ii) generating prototypes, (iii) testing feasibility (equated to *perceived ease of use*), and (iv) designing for ‘belief and recognition’ (equated to *perceived usefulness*), necessary for the user to engage with the system. The authors acknowledged that assessments for acceptance were conducted ‘rather informally’, and noted the need for a standardised approach to design for user acceptance.

A study by Eilu examined design for acceptance of a mobile voting system in Uganda (Eilu, 2021). The author evaluated ‘anticipated user experience’, through (i) briefing participants on mobile voting, (ii) observing their use of the prototype, and (iii) interviewing them on the utility of the current voting system, its ease of use, limitations, and influence on their *attitude towards using* mobile voting. Participants were asked which features in the prototype ‘positively influenced their perceptions towards the use’ of mobile voting. Findings resulted in the identification of six design strategies to “influence [users’] positive perceptions” of technology, out of which designing for *perceived usefulness* and *perceived ease of use* were deemed the most successful in influencing user acceptance.

In accessibility research, Van der Geest and Buimer, referring to the TAM3 (Venkatesh & Bala, 2008), argued for considering *perceived usefulness* and *perceived ease of use* as two “very important predictors of acceptance and use” (Van Der Geest & Buimer, 2015, p. 384). The authors reported the difficulty of addressing these acceptance factors in design:

« *At best, a prototype is presented to a limited number of representative users who are asked to judge the expected or perceived ease of use. Such evaluation studies do not reveal much about the perceived usefulness of the innovation.* » (Van Der Geest & Buimer, 2015, p. 384)

This difficulty might have been mitigated by considering the 13 antecedents to these factors proposed in the TAM3 (e.g. *subjective norm*, *computer self-efficacy*, etc.), providing a set of concrete elements to examine.

A different approach to “achieve system acceptance by design” is that of Detjen et al., who (i) reviewed existing literature on the study field (automated vehicles) and gathered user requirements, (ii) reviewed existing models of user acceptance for the field of study, (iii) compared the different sets of acceptance factors

and identified main acceptance challenges, (iv) reviewed existing approaches addressing these challenges in the field, and (v) formulated guidelines to design for acceptance of automated vehicles (Detjen, Faltaous, Pflöging, Geisler, & Schneegass, 2021, p. 322). However, this proposed design method highly grounded in user acceptance theory requires significantly more effort and time than the previous ones.

Consequently, the challenges to design for user acceptance can be summarised as follow. While we recognise researchers' effort to rely on validated acceptance theories, current practices seem to focus on a subset of acceptance factors. Overlooking other relevant acceptance factors might in fact produce the reverse outcome, resulting in designs that are not accepted by users. Secondly, we observed that the lack of standardised approaches to design for acceptance left designers uncertain as to how to address acceptance factors in design practice. This might result in a greater focus on acceptance at deployment stage, instead of during the design process. Finally, while some rare studies attempted to account for a wider range of acceptance factors in design, doing so required an extensive review of the literature — an approach that cannot be sustained in a world of rapidly and continually changing technology.

2.3.4 Evaluation Methods

Both definitions and more detailed models of acceptance may find expression in the form of approaches to measurement. A major strand of work on the measurement of user acceptance is formed by the studies validating acceptance models. Particularly, these studies provide a guide for researchers investigating user acceptance and have the potential to influence future research practice. This section therefore examines the measurement tools, study settings, and measurement timeline of studies validating acceptance models.

Measurement Tools

Studies validating acceptance models followed an approach involving the evaluation of each potential acceptance factor (e.g. *perceived health threat*), against self-reported usage behaviour. The majority of studies employed questionnaires, relying on 7-point Likert scales (Venkatesh & Davis, 2000; Venkatesh, 2000; Venkatesh & Bala, 2008; Venkatesh et al., 2003, 2012; C.-L. Hsu et al., 2013; Kim & Park, 2012), or 5-point Likert scales (Dou et al., 2017), from strongly agree to strongly disagree. Each factor was evaluated through a number of theory-based measurement items, ranging from a minimum of 2 to a maximum of 11. Davis et al. described the development of these measurement items as follow: (i) generating 14 candidate items for each construct, based on their definition, (ii) pre-testing these items to refine the wording, (iii) narrowing down the set to 10 items per construct, (iv) assessing the reliability and validity of this subset, (v) narrowing down to 6 items per construct, (vi) repeating validity assessment and narrowing down to 4 items per construct. Some studies piloted the questionnaire with focus groups (Venkatesh & Davis, 2000; Venkatesh, 2000; Dhagarra et al., 2020), or a sample of users (Dhagarra et al., 2020), to ensure the use of a clear, reality-grounded vocabulary. The majority of these studies used Cronbach's alpha coefficients to assess the internal consistency of the measurement questionnaire.

Study Settings

Almost all studies validating acceptance models measured user acceptance through empirical work in the field, involving students (F. D. Davis et al., 1989; C.-L. Hsu et al., 2013), industry employees (e.g. real estate (Venkatesh & Davis, 2000), financial services (Venkatesh, 2000), manufacturing (Venkatesh & Bala, 2008), entertainment (Venkatesh et al., 2003)), smartphone owners (Venkatesh et al., 2012), and patients (Kim & Park, 2012; Dou et al., 2017; Dhagarra et al., 2020). One exception is the research conducted by Hsu et al. (C.-L. Hsu et al., 2013), which took place in lab settings and assessed acceptance after participants used the system for a couple of minutes. Sample size varied from small samples of under 70 participants (Venkatesh & Davis, 2000; Venkatesh, 2000; Venkatesh & Bala, 2008; Venkatesh et al., 2003), to larger samples (F. D. Davis et al., 1989; Kim & Park, 2012; Dou et al., 2017; Dhagarra et al., 2020), up to over 1,500 people (Venkatesh et al., 2012). It is interesting to note that studies validating the TAM2, TAM2', TAM3 and UTAUT involved several companies (up to 4). Their sample size being on the smaller side, the strength of these works resides in the diverse pool of users whose acceptance was measured. Besides, while recruitment in clinical settings is often deemed difficult, the studies involving patients succeeded in recruiting a large number of participants, through collaboration with healthcare professionals (Dou et al., 2017).

Measurement Timeline

Most validation studies evaluated technology acceptance at different time points in the user journey. For instance, the TAM study (F. D. Davis et al., 1989) looked at the stages of *pre-use*, asking participants to fill in the first acceptance survey after watching a demo of the system, and *post-use*, giving the second questionnaire after 14 weeks of use. Drawing on this methodology but going a step further, the following studies assessed user acceptance at three time points in the user journey, including pre-use, after 1-month use, and after 3-month use (Venkatesh & Davis, 2000; Venkatesh, 2000; Venkatesh & Bala, 2008; Venkatesh et al., 2003, 2012). This aligns with the body of work (later published) theorising acceptance as a multi-stage process (N. Martin et al., 2015; Distler et al., 2018; Terrade et al., 2009; Garces et al., 2016; Somat et al., 2012; Rogers, 1983). Surprisingly, the most recently published validation studies steered away from this longitudinal measurement approach, assessing user acceptance at one single point, post-uptake of the technology (C.-L. Hsu et al., 2013; Kim & Park, 2012; Dou et al., 2017; Dhagarra et al., 2020). In addition, it was highlighted by Venkatesh and Davis that acceptance research might benefit from investigating user acceptance earlier, during the design process:

« Future research might profitably seek to establish how early in a system development process, for example, even before a working prototype is built, we can measure key user reactions, such as perceived usefulness and intention, and still rely on them as indicators of post-implementation success of the system concept. » (Venkatesh & Davis, 2000, p. 200)

However, the body of work exploring acceptance during the process of design is not large. Amongst the

model validation studies, only one looked into user acceptance of a technology yet to be developed: Dhagarra et al. asked participants to read a scenario about a fictional technology, before answering an acceptance survey (Dhagarra et al., 2020).

2.4 Conclusion

Designing technologies for health and mental health requires negotiating a complex design space, involving vulnerable user groups, often multiple stakeholders, and the handling and processing of sensitive data. These systems are likely to have a direct, critical impact on the life and health of their users. Various design philosophies, drawing on User-Centred Design, and validation methods have been proposed, all associated with a range of challenges and opportunities. In particular, we have seen that: barriers to the involvement of users in certain contexts might limit participatory and somaesthetic design; conducting value-sensitive design in the healthcare domain might require dealing with conflicting values; and the association between the use of persuasive design and health-related behaviour change was not straightforward. The literature review also highlighted the existence of biases and paradoxes that might impede the quality of digital health and mental health interventions, risking a negative impact on the wellbeing of end-users. We have also observed the wide range of digital solutions addressing health and mental health difficulties, but also the difficulty to involve diverse samples of users in validation studies, and evaluating such technologies in clinical contexts.

Furthermore, while clinical effectiveness is critical to the success to digital interventions for health and mental health care, a lack of user acceptance will impede individuals' uptake and long-term use of the technology. User acceptance is thus a core challenge for successful health and mental health technologies, and a question that requires consideration at the early stages of design, and throughout the technology lifecycle. We have seen in this chapter that the theoretical landscape on user acceptance is dense, and includes a rich set of definitions, models, and measurement methods. In light of this, we need to acknowledge the complexity of the theoretical landscape of acceptance, particularly when applied to the context of digital health and mental health. Finally, this chapter has revealed ambiguities in the terminology used in studies evaluating acceptance (e.g. *acceptability*, *acceptance*, *adoption*), a large number of validated models (16 reviewed here), and the challenges designers face when attempting to address user acceptance in the design process.

To advance our knowledge on user acceptance of health and mental health technologies, we next explore how researchers in digital health understand the notion of user acceptance, and address this issue in research practice.

Chapter 3

Research Practices Discussing & Measuring User Acceptance

The previous chapter has revealed the complexity of the theoretical frameworks on user acceptance of health and wellbeing technologies. This chapter explores the practical application of this framework, in terms of how researchers understand the notion of user acceptance, and how they make use of existing definitions, models, and measurement methods to address acceptance in practice. We present a scoping review outlining research practices addressing user acceptance in the domain of mobile health technologies. This review reveals the discrepancies between acceptance theoretical frameworks and research practices in the digital health domain. A better understanding of these elements contributes toward the development (or improvement) of methodologies and measurement tools for addressing technology acceptance within the development of digital health technologies. Informed by this analysis, we propose the Technology Acceptance Lifecycle (TAL), a temporal, theory-based model introducing a more explicit terminology and articulating the different stages of the user acceptance process: *pre-use acceptability*, *initial use acceptance*, and *sustained use acceptance*. This chapter contributes to answering the first Research Question¹.

3.1 Methods

We performed a scoping review to map user acceptance literature in the field of mobile health (mHealth). In contrast to systematic and narrative reviews (Levac, Colquhoun, & O'Brien, 2010), scoping reviews allow for a broad but structured exploration, that permitted us to examine the range of definitions and measurement methods for technology acceptance, and to identify gaps and inconsistencies in the existing literature. We followed the framework developed by Arksey and O'Malley (Arksey & O'Malley, 2005), which consists of the stages outlined below.

¹RQ1: How is user acceptance of health and wellbeing technologies defined, discussed, designed for, and measured, both in theory and in practice?

3.1.1 Searching for Relevant Studies

We searched the PubMed database for papers addressing technology acceptance. Preliminary searches allowed us to assess the relevance of the search criteria, and determine the feasibility of the review based on the the number of papers returned by the search. Building on this, we decided on a search using the Medical Subject Headings (MeSH) terms “Patient Acceptance of Health Care” and “Mobile Applications”, without time restriction. The search resulted in a corpus of 287 articles starting from 2013.

3.1.2 Selecting Studies to Include

Inclusion criteria were subject to discussion; two random samples of 10 papers were independently assessed for inclusion. Disagreements concerning the definitions of inclusion criteria were resolved by explicitly stating these criteria as follow: a publication was considered relevant if it contained at least one of the terms “acceptability”, “acceptance”, “adoption”, “accept”, or “adopt” and defined the concept in question with (i) a full definition, (ii) a synonym, or (iii) an operationalised definition (i.e. means used to measure the concept). The inclusion criteria were applied at screening and eligibility stages, detailed in the PRISMA² diagram Fig. 3.1. Screening the titles and abstracts allowed to exclude 40 articles which were associated with the specified MeSH terms, but did not directly discuss technology acceptance (e.g. Acceptance and Commitment Therapy). We then assessed the eligibility of the remaining articles, excluding those that did not contain any of the five terms above, did not provide a definition, or were not accessible online. A total of 68 relevant publications were included in the review.

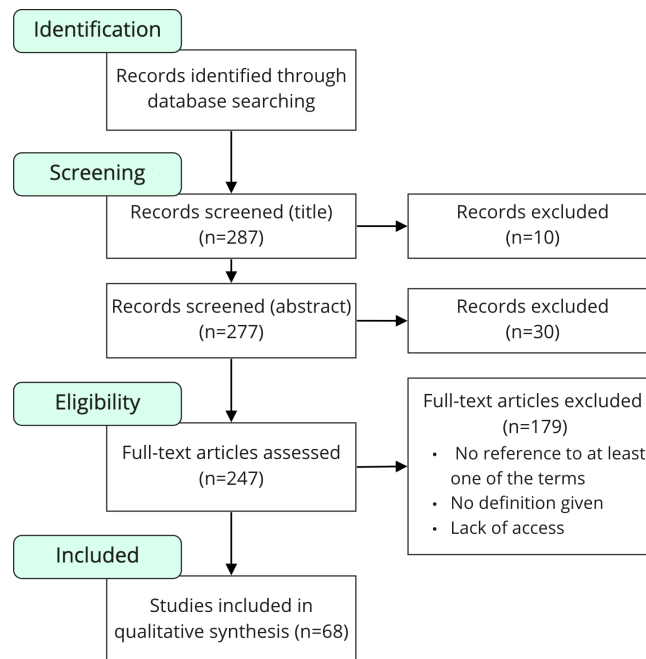


Figure 3.1: Scoping review flow diagram.

²Preferred Reporting Items for Systematic Reviews and Meta-Analyses (Tricco et al., 2018).

3.1.3 Charting the Data

The codes used for analysis aimed to expose how technology acceptance was referred to, defined, and measured, depending on the context (Tab. 3.1). The same two samples of 10 papers (independently assessed for inclusion) were then independently charted. The charting resulted in no disagreement, and the codes were straightforward to interpret.

Table 3.1: Distribution of the main codes. [Some studies performed multiple measurements.]

Themes and codes	Studies, n (%)
Given definition	68 (100)
Term used	
Acceptability	50 (74)
Acceptance	20 (29)
Adoption	11 (16)
Nature of given definition	
Operationalised	39 (58)
Synonym	22 (32)
Full definition	7 (10)
Cited reference for given definition	
Yes	13 (20)
No	55 (80)
Intervention domain	
Mental health	55 (80)
Health	12 (18)
Both	1 (2)
Goal of assessing acceptance	
Inform design	13 (19)
Evaluate a system	48 (71)
Review the literature	7 (10)
Acceptance measurement	
Customised survey	39 (54)
Standardised survey	13 (18)
Usage	7 (10)
Interviews (qualitative)	6 (9)
Focus groups (qualitative)	5 (7)
Adherence	1 (1)
Completion of task	1 (1)
Measurement timeline	
Pre-use	16 (19)
Initial use	7 (10)
Sustained use	42 (61)
Unclear	1 (1)
No measurement	6 (9)

3.1.4 Collating, Summarising, and Reporting the Findings

The strand of work on temporality (reviewed in Chapter 2) distinguishes between the different stages of the process of acceptance. We assessed whether the definitions found in our corpus also differentiated between the stages of acceptance and the terms *acceptability*, *acceptance*, and *adoption*. Based on the charting, we classified the papers as follow: firstly with respect to the terminology used (i.e. *acceptability*, *acceptance*, or *adoption*); secondly with respect to the measurement stage (i.e. *pre-use*, *initial use*, or *sustained use*). We then grouped papers with similar definitions of acceptance, and extracted the measurements used. Finally, we

identified possible gaps, and suggested ways to improve the exploration of acceptance in the mHealth field.

3.2 Results

All three terms (*acceptance*, *acceptability*, and *adoption*) were used in the mHealth literature sample, and were associated with various meanings and measurements.

3.2.1 Discussing & Defining User Acceptance

Charting of the papers reveals that one-fifth of them cited definitions from the literature. Two-third of the articles reported on a mental health intervention, which shows that the question of technology acceptance is particularly studied in this context. Figure 3.2 compares the terminology used in the papers, with a classification following the measurement stage. A significant difference can be seen between the two distributions, marking the distinction between the three terms, but also their use in relation to the measurement timeline.

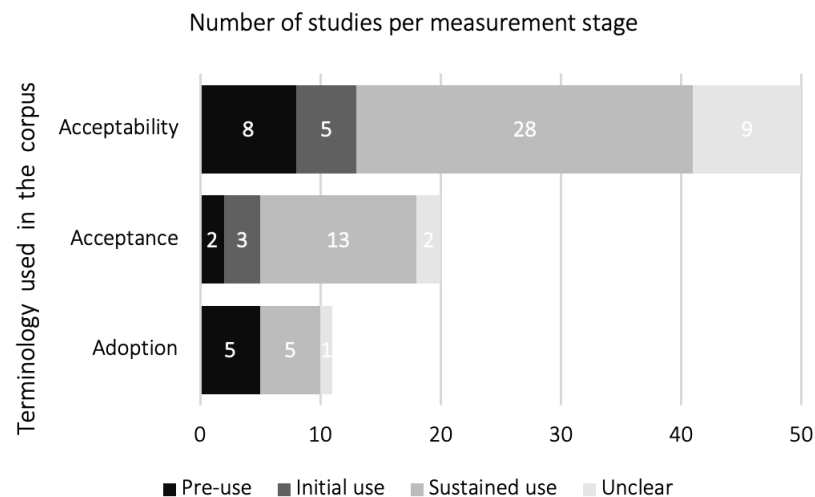


Figure 3.2: Comparison of the terminology used, with a classification of the measurement stage. [Some papers employed multiple terms.]

The majority of publications (n=51) referred to technology *acceptability*. Among these, a small number (n=8) addressed the *pre-use* stage, sometimes equating *acceptability* to users' interest or willingness to use a system (Sharpe et al., 2018; Abelson, Symer, Peters, Charlson, & Yeo, 2017; Gardner et al., 2017; Peterson, Apolzan, Wright, & Martin, 2016). The other 34 papers referred to *acceptability* in the context of *initial* or *sustained use*. Papers in the second group (n=20) referred to technology *acceptance*. Among these, 2 papers address the *pre-use* stage, and 13 the *sustained use* stage. The last part of the corpus (n=11) refers to technology *adoption*. Half of these papers focused on the *sustained use* stage and the other half on the *pre-use* stage. Papers reported as unclear were those for which classification was not possible as the context of the study was ambiguous. Although the terminology used shows a focus on *acceptability*, looking at the corpus through the lens of the measurement timeline highlights that more than two-third of the papers (n=47) explored the *sustained use* stage. This distribution suggested a trend in the corpus to employ the term *acceptability*,

regardless of the context and stage of the user journey. Table 3.2 presents the range of interpretations for *acceptability*, *acceptance*, and *adoption* extracted from the corpus.

This distribution reveals that *acceptability* was mainly understood as perceived usefulness (a concept from TAM) or user satisfaction. System usability, user feedback, and the other TAM constructs (perceived ease of use, attitude toward use, intention to use, and actual usage) were often mentioned. It also emerged that researchers may consider a reduction of the stigma perceived by users (Liu et al., 2016) and a high similarity between the behaviour of the technology and traditional healthcare (Juarascio et al., 2015) as markers for *acceptability*. Furthermore, one study explored socio-cultural aspects of technology *acceptability* in developing regions, explaining that a system needs to take into account “the preferences and aspirations of individual service users and the cultures of their communities” (Peiris, Praveen, Johnson, & Mogulluru, 2014). A striking finding was that, out of six years of research, only two works explored mHealth for children (Ginsburg et al., 2016; Farooqui, Phillips, Barrett, & Stukus, 2015), with Farooqui et al. (Farooqui et al., 2015) alone studying children’s acceptance.

Fewer studies employed the term *acceptance*, associating it with constructs from the TAM — perhaps because the model itself uses the term acceptance. TAM constructs were also found in the interpretations of *adoption*. Some of this work seeks to adapt or extend the TAM, such as Khatun et al. (Khatun et al., 2015), who developed the concept of *readiness to adopt* mHealth in developing countries. The authors argued that the TAM “does not consider the influence of human factors, the internal resources of the user or the external environmental and ecological factors” (Khatun et al., 2015, p. 848) and proposed a model integrating TAM constructs and others more specific to rural and developing areas (access, socio-demographics, awareness of mHealth services, and trust).

Among the literature reviews present in the corpus, some associated *acceptability* or *acceptance* with feasibility (Bashshur et al., 2016; Jongbloed, Parmar, van der Kop, Spittal, & Lester, 2015). Feasibility, as defined by the National Institute for Health Research glossary, relates to whether a study can be carried out. A feasibility study explores not only technical parameters, but also human factors likely to be important for the conduct of the main study. Although a feasibility study may include the assessment of participants’ acceptance, it is not the case that all feasibility studies will do so.

A small number of studies (n=13) cited conceptual definitions from the literature. The TAM was cited in reference to the three concepts: *acceptability* (Y. Chen et al., 2017; Brittain et al., 2018), *acceptance* (Y. Chen et al., 2017; Wang et al., 2016; De Vito Dabbs et al., 2013), and *adoption* (De Vito Dabbs et al., 2013; Zhu et al., 2018; Khatun et al., 2015). However, some studies have highlighted the limitations of existing models. Zhu et al. argued that conceptual models should not regard mobile services as a generic concept but specifically address particular use cases, such as mobile services for health monitoring (Zhu et al., 2018). The authors presented their own model for technology acceptance, combining TAM constructs with health-related concepts from the Health Belief Model (Rosenstock, 1974). In the same vein, Povey et al. (Povey et al., 2016) stated that existing models were not suitable for their study. The authors attempted to build a model for the acceptability of e-mental health for an indigenous population, and acknowledged that the resulting model

Table 3.2: Meanings associated with the terminology. [Some studies referred to several concepts.]

Associated meanings	n	References
Acceptability		
Perceived usefulness	14	(Helsel et al., 2018; Guo et al., 2017; Westergaard et al., 2017; Schlosser et al., 2017; Gordon et al., 2017; Hicks et al., 2017; J. O'Brien et al., 2017; Rizvi et al., 2016; Miner et al., 2016; Sureshkumar et al., 2016; Juarascio et al., 2015; Goldstein et al., 2014; Hirst et al., 2014; Y. Chen et al., 2017)
User satisfaction	11	(Schlosser et al., 2017; Gordon et al., 2017; J. O'Brien et al., 2017; Sureshkumar et al., 2016; Brittain et al., 2018; Niendam et al., 2018; Jacobson et al., 2018; Eisenhauer et al., 2017; Isetta et al., 2017; Carter et al., 2013; Patel et al., 2013)
System usability	8	(Gardner et al., 2017; J. O'Brien et al., 2017; Jacobson et al., 2018; Schnall et al., 2018; Santo et al., 2017; Crosby et al., 2017; Hartzler et al., 2016; Sarzynski et al., 2017)
User feedback	8	(Guo et al., 2017; Westergaard et al., 2017; Juarascio et al., 2015; Santo et al., 2017; Hartzler et al., 2016; Radhakrishnan et al., 2016; Ahern et al., 2016; Simmons et al., 2016)
Rate of recommendation	8	(Helsel et al., 2018; Westergaard et al., 2017; Schlosser et al., 2017; Juarascio et al., 2015; Goldstein et al., 2014; Santo et al., 2017; Simmons et al., 2016; Bucci et al., 2018)
Actual usage	8	(Y. Chen et al., 2017; Simmons et al., 2016; Muroff et al., 2017; Hickey & Freedson, 2016; Forman et al., 2014; Ofili et al., 2018; Noblin et al., 2017; Yasini & Marchand, 2016)
Perceived efficiency	6	(Helsel et al., 2018; Miner et al., 2016; Niendam et al., 2018; Santo et al., 2017; Simmons et al., 2016; Yasini & Marchand, 2016)
Perceived ease of use	5	(Guo et al., 2017; Westergaard et al., 2017; Hirst et al., 2014; Y. Chen et al., 2017; Santo et al., 2017)
Intention to use	5	(Sharpe et al., 2018; Abelson et al., 2017; Peterson et al., 2016; Y. Chen et al., 2017; Ginsburg et al., 2016)
User engagement	4	(Rizvi et al., 2016; Simmons et al., 2016; R. Moore et al., 2017; Muroff et al., 2017)
User enjoyment	4	(Helsel et al., 2018; Rizvi et al., 2016; Y. Chen et al., 2017; Simmons et al., 2016)
Attitude toward use	2	(Liu et al., 2016; Y. Chen et al., 2017)
Quality of the system	1	(Y. Chen et al., 2017)
Acceptance		
Perceived usefulness	5	(Y. Chen et al., 2017; Rico et al., 2017; Mertens et al., 2016; Wang et al., 2016; De Vito Dabbs et al., 2013)
Intention to use	5	(Y. Chen et al., 2017; Ginsburg et al., 2016; Wang et al., 2016; De Vito Dabbs et al., 2013; Ammenwerth et al., 2015)
Actual usage	5	(Y. Chen et al., 2017; Noblin et al., 2017; Wang et al., 2016; De Vito Dabbs et al., 2013; Becker et al., 2015)
User satisfaction	4	(Patel et al., 2013; Ammenwerth et al., 2015; Wu et al., 2015; Rico et al., 2017)
Perceived ease of use	3	(Y. Chen et al., 2017; Wang et al., 2016; De Vito Dabbs et al., 2013)
Attitude towards using	3	(Y. Chen et al., 2017; Wang et al., 2016; De Vito Dabbs et al., 2013)
Perceived efficiency	2	(Rico et al., 2017; Ammenwerth et al., 2015)
System usability	2	(Sarzynski et al., 2017; Fallah & Yasini, 2017)
Quality of the system	2	(Y. Chen et al., 2017; Ammenwerth et al., 2015)
User feedback	1	(Bashshur et al., 2016)
User enjoyment	1	(Y. Chen et al., 2017)
Adoption		
Actual usage	7	(Ofili et al., 2018; Yasini & Marchand, 2016; De Vito Dabbs et al., 2013; Lee et al., 2018; Schulte et al., 2016; Noblin et al., 2017; Lobelo et al., 2016)
Intention to use	3	(De Vito Dabbs et al., 2013; Giménez-Pérez et al., 2016; Zhu et al., 2018)
Perceived usefulness	2	(Hirst et al., 2014; De Vito Dabbs et al., 2013)
Perceived ease of use	2	(Hirst et al., 2014; De Vito Dabbs et al., 2013)
Perceived efficiency	1	(Yasini & Marchand, 2016)
Attitude toward use	1	(De Vito Dabbs et al., 2013)

is similar to the HITAM (Kim & Park, 2012). Ammenwerth et al. argued that existing models, such as the TAM and Task-Technology-Fit model (Goodhue, 1995) failed to address the interaction between user and task (Ammenwerth, Iller, & Mahler, 2006). To bridge this gap, the authors developed and validated the Fit between Individuals, Task, and Technology (FITT) framework for information technology adoption in clinical environments. Only one study (Noblin et al., 2017) then employed FITT to measure acceptance of the use of mobile apps among physical therapists. Finally, another study (Lee et al., 2018) cited Agarwal and Prasad, supporting the idea of two stages, namely *initial adoption* and *long-term engagement* (Agarwal & Prasad, 1997). These references to models and definitions within the literature show researchers’ willingness to reuse existing theories. However, the adaptations of these models and their inconsistent interpretation also reveal their limitations, and the lack of a common framework to study user acceptance.

3.2.2 Measuring User Acceptance

We extracted measurements employed in the corpus to assess technology acceptance and classified them by type and temporality. Table 3.3 illustrates a strong preference for the use of surveys (73.0%, 49/68), independently of the timeline, with a prevalence of custom questionnaires (54.0%, 37/68).

Table 3.3: Measurements performed. [Some studies perform several measurements.]

Measurement	Occurrences per stage		
	Pre-use (11 studies)	Initial use (7 studies)	Sustained use (40 studies)
Customised survey	7	2	28
Standardised survey	2	2	8
Focus groups (qual.)	2	1	1
Interviews (qual.)	1	1	1
Completion of task	0	1	1
Usage	0	0	6

Almost all studies assessing system usability — a frequent interpretation of *acceptability* (see Tab. 3.2) — made use of standardised surveys, which reflects the range of reliable tools available to evaluate this concept (Schnall et al., 2018; Crosby et al., 2017). Other studies used existing surveys incorporating TAM constructs (Y. Chen et al., 2017; De Vito Dabbs et al., 2013), or developed their own with elements from different models to fit their research better (Zhu et al., 2018). Owing to the need to assess technology acceptance in developing countries and remote areas, Chen et al. (Y. Chen et al., 2017) suggested that models found in the literature may need to be validated on a larger variety of populations. The rest of the corpus measured user acceptance through participant feedback (via custom surveys, focus groups, and interviews), adherence, usage, and rate of completion of tasks. Although this wide set of metrics contributes to expanding the number of assessment tools, it also impedes consistency within user acceptance research. Table 3.4 reveals that the large majority of the corpus measured acceptance at sustained use stage, showing researchers’ strong tendency to address the question of acceptance when evaluating long-term use of technology. The low number of measures applied at the *pre* and *initial use* stages also reveals that technology acceptance was rarely investigated in design.

Table 3.4: Measurement timeline of the constructs. [Some studies measured several constructs.]

Construct, n	Measurement stages		
	Pre-use (n=3)	Initial use (n=7)	Sustained use (n=87)
Perceived usefulness (18)	(Juarascio et al., 2015)	(McManama O'Brien et al., 2017; Rizvi et al., 2016)	(Guo et al., 2017; Westergaard et al., 2017; Schlosser et al., 2017; Gordon et al., 2017; Hicks et al., 2017; Rizvi et al., 2016; Sureshkumar et al., 2016; Miner et al., 2016; Goldstein et al., 2014; Hirst et al., 2014; Y. Chen et al., 2017; Rico et al., 2017; Mertens et al., 2016; Wang et al., 2016; De Vito Dabbs et al., 2013)
User satisfaction (15)	-	(McManama O'Brien et al., 2017; Brittain et al., 2018)	(Schlosser et al., 2017; Gordon et al., 2017; Sureshkumar et al., 2016; Goldstein et al., 2014; Niendam et al., 2018; Rico et al., 2017; Ammenwerth et al., 2015; Wu et al., 2015; Patel et al., 2013; Jacobson et al., 2018; Eisenhauer et al., 2017; Isetta et al., 2017; Carter et al., 2013)
Intention to use (11)	(Sharpe et al., 2018; Abelson et al., 2017; Peterson et al., 2016; Giménez-Pérez et al., 2016; Zhu et al., 2018; Khatun et al., 2015)	-	(Y. Chen et al., 2017; Ginsburg et al., 2016; Wang et al., 2016; De Vito Dabbs et al., 2013; Ammenwerth et al., 2015)
System usability (10)	(Gardner et al., 2017)	(McManama O'Brien et al., 2017)	(Gordon et al., 2017; Jacobson et al., 2018; Schnall et al., 2018; Sarzynski et al., 2017; Fallah & Yasini, 2017)
Rate of recommendation (10)	(Juarascio et al., 2015)	-	(Westergaard et al., 2017; Schlosser et al., 2017; Gordon et al., 2017; Goldstein et al., 2014; Santo et al., 2017; Simmons et al., 2016; Bucci et al., 2018; Farooqui et al., 2015; Hochstenbach et al., 2016)
Actual usage (9)	-	-	(Y. Chen et al., 2017; Muroff et al., 2017; Simmons et al., 2016; Forman et al., 2014; Ofili et al., 2018; Yasini & Marchand, 2016; Wang et al., 2016; De Vito Dabbs et al., 2013; Becker et al., 2015)
User feedback (8)	(Juarascio et al., 2015; Radhakrishnan et al., 2016)	(Ahern et al., 2016)	(Guo et al., 2017; Westergaard et al., 2017; Santo et al., 2017; Hartzler et al., 2016; Simmons et al., 2016)
Perceived ease of use (7)	-	-	(Guo et al., 2017; Westergaard et al., 2017; Hirst et al., 2014; Y. Chen et al., 2017; Santo et al., 2017; Wang et al., 2016; De Vito Dabbs et al., 2013)
Perceived efficiency (6)	-	-	(Miner et al., 2016; Niendam et al., 2018; Santo et al., 2017; Simmons et al., 2016; Yasini & Marchand, 2016; Rico et al., 2017; Fallah & Yasini, 2017)
Attitude toward use (4)	(Liu et al., 2016)	-	(Y. Chen et al., 2017; Wang et al., 2016; De Vito Dabbs et al., 2013)
User enjoyment (4)	(Rizvi et al., 2016)	(Rizvi et al., 2016)	(Y. Chen et al., 2017; Simmons et al., 2016)
User engagement (3)	-	-	(Simmons et al., 2016; Muroff et al., 2017; R. Moore et al., 2017)
Quality of the system (2)	-	-	(Y. Chen et al., 2017; Ammenwerth et al., 2015)

Interestingly, although existing acceptance models provide sets of measurable constructs, researchers' efforts have focused on *perceived usefulness*. Only the studies in Table 3.5 measured the full set of constructs provided by the validated models of acceptance (or technology use) that they cite. Table 3.5 shows that almost all studies that relied on the TAM added constructs to capture the influence of context-related factors on acceptance. Indeed, Zhu et al. (Zhu et al., 2018) followed the added variables approach, described by Holden and Karsh (Holden & Karsh, 2010), to evaluate the acceptance of their technology within the specific Chinese health care context. In addition to the TAM constructs, they used four context-related constructs taken from other studies. Similarly, Chen et al. (Y. Chen et al., 2017) used a questionnaire based on the TAM with additional constructs from other studies to fit the context of their application. Finally, Wang et al. (Wang et al., 2016) showed the influence of certain demographic factors (age, position at work, usage time, and skill level of using the technology) on the TAM constructs (*perceived usefulness* and *ease of use*). On the other hand, Ammenwerth et al. (Ammenwerth et al., 2015) used a survey based on the Information System Success Model (Delone & McLean, 2003) to evaluate acceptance *post-use* at two different points in time. The first survey assessed the 7 constructs from the model, whereas the second only assessed *intention to use* and *net benefit*. This could suggest that these constructs are seen as more stable or important, or that the existing constructs are not suitable for all study designs.

Table 3.5: Use of validated technology acceptance models in the corpus.

Validated models	Occurrences per stage		Additional constructs
	Pre-use	Initial use Sustained use	
TAM	(Zhu et al., 2018)		Perceived disease threat, perceived risk, initial trust, and technology anxiety
			System quality, social influence, perceived enjoyment, smartphone experience
		(Wang et al., 2016)	Demographics (age, job, usage time, and skill level of using the technology)
		(De Vito Dabbs et al., 2013)	None
Information System Success Model		(Ammenwerth et al., 2015)	None

As expected from the analysis of definitions, these studies measured a wide variety of constructs. New questionnaires were developed, and researchers stressed the limitations of validated measurement frameworks. Validating these new surveys could be of great benefit to the field, as it would provide a range of readily available tools to measure user acceptance in a wider diversity of technological and human contexts.

3.3 Discussion

This scoping review analysed the terminology used to refer to technology acceptance, and extracted the different interpretations given and measurement methods employed. To conclude this chapter, we reflect on the findings, and discuss the challenges of differentiating terminology, linking interpretations of acceptance

to existing theories, and creating more adapted models and measurement tools. Finally, we propose the Technology Acceptance Lifecycle (TAL), a temporal, theory-based model introducing a more explicit terminology and articulating the different stages of the user acceptance process: *pre-use acceptability*, *initial use acceptance*, and *sustained use acceptance*.

3.3.1 Differentiating Terminology

The findings reveal that user acceptance was mostly referred to as *acceptability* and, to a lesser extent, *acceptance* or *adoption*. A small part of the corpus converges toward the differentiation of these terms as distinct concepts, corresponding to stages (i.e. *pre-use acceptability*, *initial* and *sustained use acceptance*) or events (i.e. point of *adoption*) in the user acceptance journey. However, the rest of the corpus does not distinguish between these terms. One reason could be that the existing definitions arguing for that distinction were published separately. Hence, providing a coherent and more precise terminology and set of definitions can aid researchers in communicating which concepts they are referring to.

3.3.2 Linking Interpretations of Acceptance to Existing Theories

The corpus provided a variety of interpretations of the concept of user acceptance. Among these, some were based on constructs present in literature models such as the TAM (F. D. Davis et al., 1989), indicating that validated models do influence acceptance studies. Other definitions should be associated with constructs in validated acceptance models. For example, factors related to the sensitive nature of health care technologies (such as *perceived stigma*) should be linked to the constructs *subjective norm*, *social influence*, and *image* in validated models (Taylor & Todd, 1995; Venkatesh & Davis, 2000; Venkatesh & Bala, 2008; Venkatesh et al., 2003, 2012; Kim & Park, 2012). Thus, it is likely that the extent to which an individual is concerned by these risks will impact their acceptance of the technology. Following previous research (Zhu et al., 2018; Povey et al., 2016), we argue that acceptance models should take into account the variety of cultural and health contexts of users.

3.3.3 Creating More Adapted Models & Measurement Tools

Although part of the corpus employed standardised tools, the majority of the studies used custom surveys. This aligns with the findings of Wozney et al. that the major part of their corpus used non-validated measures of acceptability (Wozney et al., 2018). This could be the result of the narrow set of validated tools to assess user acceptance in the context of health and mental health care. Many researchers felt the need to design their own survey to have a measurement instrument adapted to the specific issues of their target population (e.g. technology access and cost). Similarly, researchers who used existing acceptance models felt the need to add context-specific constructs. It would be interesting to see a community effort to validate new tools, create adapted tools for important contexts such as digital mental health, and adapt existing models and

questionnaires so that they embrace the longitudinal nature of the process of user acceptance.

Finally, technology acceptance was rarely investigated at the design stage. While exploring acceptance issues could greatly inform design work (Matthews et al., 2015), and reduce risks that an implemented technology is rejected or abandoned, this result aligns with the findings of Chapter 2 revealing the challenges designers face in addressing acceptance at design stage. On the use of machine learning in clinical contexts, Thieme et al. (Thieme, Belgrave, & Doherty, 2020) argue that collaborating with health care users at the design stage may increase the chances of acceptance of the technology. Yet, validated acceptance models were only used once to measure acceptance at the *pre-use* stage (see Tab. 3.5). A reason for this might be that existing models do not target the design stage, and are not adapted to measuring user acceptance of technology before its first use.

3.3.4 The Proposed Technology Acceptance Lifecycle (TAL)

In line with the existing literature definitions and informed by our analysis of the corpus, we argue for clearly distinguishing between the different stages of user acceptance. We have seen in our analysis both a wide variety of interpretations of these concepts, and a range of measurement approaches applied across the lifecycle, mostly based on ad-hoc tools. This variety creates ambiguities in the reporting and understanding of results, and makes it difficult to draw conclusions on the acceptance of the systems studied. We believe that a better understanding of the process of user acceptance, and its temporal dimension, would greatly benefit the community, in terms of researchers designing acceptance studies, and articulating their findings, with regard to the entire process. To contribute toward clarification of the longitudinal measurement of user acceptance, we propose the Technology Acceptance Lifecycle (TAL), a timeline anchoring the definitions of user acceptance within the overall process (Figure 3.3).

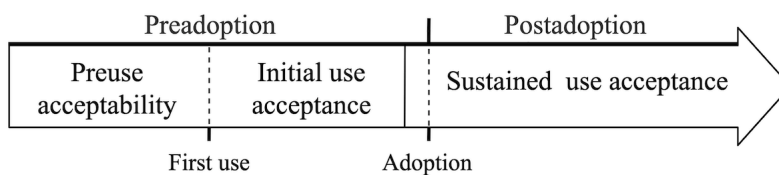


Figure 3.3: Proposed terminology for technology acceptance lifecycle.

Our motivation with the TAL is to highlight the evolving nature of user acceptance, across the different stages of the user journey with a technology. The two main stages of the timeline follow Karahanna et al. and Roger's interpretations in favour of a distinction between the *pre-* and *post-adoption* stages (Karahanna et al., 1999; Rogers, 1983). With regard to the strand of research supporting a multi-stage process of acceptance (Sekhon et al., 2017; N. Martin et al., 2015; Distler et al., 2018; Terrade et al., 2009; Garces et al., 2016; Somat et al., 2012; Rogers, 1983), we argue for a distinction between the stages of *acceptability* (pre-use) and *acceptance* (post-use). We also differentiate *initial use*, from *sustained use*, by relating the former to the novelty of interacting with the technology, and discovery of some of its features by the user, and the latter to prolonged,

more expert use of technology. The TAL not only articulates the process of user acceptance and its different stages across the user journey, but also introduces a more explicit terminology, embedding temporality in the name of the different stages. We therefore propose the 3-stage continuum of *pre-use acceptability* – *initial use acceptance* – *sustained use acceptance*. Besides, sometime during the *sustained use* stage, the user would reach the point of *adoption* of the technology. According to Rogers, a system can be considered adopted when users make full use of it (Rogers, 1983). However, the literature does not specify the conditions for full use to be achieved.

We finally define *user acceptance* as individuals’ perception of the technology, leading to its use or non-use, and differentiate it from the *user acceptance journey*, a sequence of experiences, each susceptible to changing the user’s perception of the technology. To conclude, we suggest that the research community considers acceptance as a process — rather than a discrete measure — and adopts measurement approaches that account for the temporal dimension, and possible evolution, of user acceptance. We believe that the proposed TAL could help align the research field, and provide researchers with a timeline that they can follow to evaluate user acceptance, and terminology to communicate their research clearly. Further research is needed to establish the influencing factors at the different stages of the process, and to develop and validate measurement methods adapted to these stages.

3.4 Limitations

Our search focused on the PubMed database and relied on the MeSH classification. We did not apply any time restriction, and obtained a reasonably sized and highly relevant sample. However, a more exhaustive sample could be obtained by expanding the search to more generic wordings (e.g. ‘health technologies’) or other terms (e.g. ‘virtual reality’).

3.5 Conclusion

This chapter examined how user acceptance of health and wellbeing technologies is defined, discussed and measured in research practice. We have looked at the particular case of user acceptance of mobile health technologies, and reviewed the research practices of 68 studies. Within these, we have identified the common interpretations and measurement approaches that have been used to assess user acceptance of mHealth technologies. In addition, this review has described how mHealth researchers made use of validated models to measure user acceptance, and the lack of readily available evaluation tools that are appropriate for specific study contexts, and for use at the design stage.

This work has uncovered the need for (i) a clarification of the timeline of the user acceptance process, (ii) the development of approaches to address user acceptance of health and mental health care technologies at design stage, and (iii) guidance for the longitudinal evaluation of user acceptance of digital health and

wellbeing. The proposed Technology Acceptance Lifecycle (TAL) addressed the first point, by introducing a more explicit terminology, and a longitudinal representation of the user acceptance journey. Our findings highlighted the importance of better articulating the specific concepts highlighted in the TAL and developing appropriate measurement tools, ideally standardised, for each of these concepts. This perspective therefore encourages designers to consider acceptance across the user journey, and allows researchers to be more explicit about what they are investigating. In addition, efforts from the research community are needed to adapt existing acceptance models for use in sensitive contexts such as mental health interventions.

Highlighting the lack of consideration of user acceptance at design stage, this review leads us to wonder how we can help designers of health and mental health care technologies gain a rich understanding of the process of acceptance, and apply this knowledge into their practice to design technologies which are accepted by people. The next chapter will thus look into an approach to facilitate design for user acceptance.

Chapter 4

Supporting the Design for Acceptance of Health & Wellbeing Technologies

The literature review in Chapter 2 brought out the complexity of the theoretical frameworks on user acceptance, and the challenges designers face in addressing acceptance in the process of design. We hypothesised that these issues would result in a lack of consideration of user acceptance at design stage, which was confirmed by the scoping review of mobile health literature in Chapter 3. Yet, investigating acceptance as early as design stage is helpful to inform design work (Matthews et al., 2015), and reduce the risk of rejection or abandonment of technology, particularly when involving healthcare service users in the design process (Thieme et al., 2020). The scoping review also outlined the discrepancies that exist between theory and research practice, suggesting that researchers experience difficulties in leveraging the theoretical landscape on acceptance. Therefore, there is a need to support designers of health and wellbeing technologies in leveraging acceptance theories into design practice. In this chapter, we introduce a novel, theory-based design tool and method, the Technology Acceptance (TAC) toolkit, and explore how it could facilitate the design for user acceptance. We examine the use of the TAC toolkit during 7 workshops conducted with 21 designers of health and mental health technologies, with interdisciplinary expertise. These workshops were designed to explore the macro-temporal perspective as a means to support design for acceptance. Finally, this chapter discusses implications for considering user acceptance as a dynamic, multi-stage process in design practice, and better supporting designers in imagining distant user acceptance challenges. The work presented in this chapter contributes to answering the second Research Question¹. This work is a collaboration with Copenhagen Center for Health Technology. I conceptualise the TAC toolkit, designed the methodology and applied for ethics approval, conducted the workshops and interviews, curated and analysed the data, and managed the project. I iterated on the methodology with Shane McCully and Dr Kevin Doherty; they also participated in conducting the study and Shane helped with the inductive thematic analysis.

¹RQ2: How can the theoretical landscape of user acceptance, including the temporal dimension of the process, be made more accessible to designers of health and wellbeing technologies, and incorporated into real design practice?

4.1 Design Tools to Bridge Theory & Practice and Represent User Trajectories

HCI researchers and designers have previously devised a variety of methods for bridging theory and practice (Dalsgaard & Dindler, 2014; Velt, Benford, & Reeves, 2020) during the early stages of technology design (Sas, Whittaker, Dow, Forlizzi, & Zimmerman, 2014), including cards (Halskov & Dalsgård, 2006), personas, scenarios, and toolkits (Peters, Loke, & Ahmadpour, 2020; Khairuddin, Sas, & Speed, 2019; Ledo et al., 2018; Sas & Neustaedter, 2017; Umair, Sas, & Alfaras, 2020). Design cards in particular are often employed in early design, to support reflection, ideation, and communication (Peters et al., 2020; Bornoe, Bruun, & Stage, 2016) in collaborative design (Kwiatkowska, Szóstek, & Lamas, 2014; Halskov & Dalsgård, 2006; Wölfel & Merritt, 2013).

The potential of these methods to succinctly communicate theoretically abstract concepts has led to the development of cards articulating concepts and models as diverse as the Tangible Interaction framework (Hornecker, 2010), Exertion framework (Mueller, Gibbs, Vetere, & Edge, 2014), Playful Experiences framework (Lucero & Arrasvuori, 2010), and child developmental concepts (Bekker & Antle, 2011). Designers of these cards decks have drawn on a variety of means of communication, from sensitising questions and illustrative images (Hornecker, 2010), to images and thematic thought-provoking questions (Mueller et al., 2014), quotes, and both textual and graphical descriptions of activities (Bekker & Antle, 2011). Examples of such card decks, albeit not integrated in toolkits, are (i) 26 printed colour-coded cards for the Tangible Interaction framework's four themes, showing sensitising questions and illustrative images (Hornecker, 2010); (ii) 14 printed colour-coded cards for the Exertion framework's four lenses, containing images and thematic thought-provoking questions to guide the design of exertion games (Mueller et al., 2014); (iii) 42 colour-coded cards for the four developmental domains across three age segments, showing on the front abstract textual description of practised ability and images of children practising it, with and without technology, and on the back quotes from children practising that skill in everyday life (Bekker & Antle, 2011).

In practice, design cards can also be supported by additional design tools, including personas and scenarios, as means of depicting and anchoring users' interactions in relation to hypothetical future systems (Dix, Dix, Finlay, Abowd, & Beale, 2003; Cooper, Reimann, & Cronin, 2012). Usually depicted in text form, scenarios can also be augmented visually (Dix et al., 2003), offering "powerful means of relating ideas to use context and work practice" (Buur, Jensen, & Djajadiningrat, 2004, p. 187), or rendered interactive, as in the case of hands-only scenarios (Buur et al., 2004), role-play (Waern et al., 2020), and Design Thing'ing scenarios (V. Sharma, Das, & Kewaley, 2015). More recently, scenarios have also been used as means to educate designers in relation to theory (e.g. social science theories (Waern et al., 2020), psychology theories (Qu, Sas, & Doherty, 2020)), or to sensitise designers to users' feelings and lived experiences (Sas, Hartley, & Umair, 2020). Personas and scenarios have been also employed for the design of health technologies (Hensely-Schinking,

de Carvalho, Glanznig, & Tellioğlu, 2015; Wärnestål, Svedberg, Lindberg, & Nygren, 2017; Van Velsen, van Gemert-Pijnen, Nijland, Beaujean, & Van Steenbergen, 2012; Vosbergen et al., 2015).

Design cards' long history of the effective communication of theory suggests their potential as means of operationalising the rich theoretical space of user acceptance, if made, and considered accessible, engaging and meaningful to practising designers. Cards can also benefit from being used alongside personas and scenarios, to represent the temporal unfolding of the user acceptance journey with digital health interventions.

4.2 Introducing the Technology Acceptance (TAC) toolkit

Chapter 2 highlighted how the dense and ambiguous set of user acceptance theories, and lack of standardised design methods engendered obstacles for designers attempting to examine the question at design stage. To address these challenges and support design for acceptance, we developed the Technology Acceptance (TAC) toolkit, which aims to (i) render user acceptance theory more accessible to designers, (ii) produce a true-to-life context in which to weigh questions pertaining to user acceptance of technology, and (iii) create a space in which to reflect upon, and begin designing for health and mental health technologies. While the literature review outlined the diverse stakeholders that might be involved in use of health and mental health care technologies, the TAC toolkit has, as its primary focus, technology acceptance by the person receiving care. Materials supporting these aims were developed through an 8-month iterative design process. Sensitively designed and informed by existing models of user acceptance, the TAC materials in their final form consist of five elements: 16 cards informed by user acceptance theory, 3 relatable personas, 3 healthcare scenarios, a virtual think-space to capture the user acceptance journey, and an interactive website.

4.2.1 Designing the TAC Cards

Designing the cards involved careful selection of relevant technology acceptance models, identification of key concepts as antecedent factors, and the design of the cards' textual and visual content.

Selecting the Models of Technology Acceptance

Drawing on the literature reviewed in Chapter 2, we selected validated user acceptance models as a theoretical basis for the TAC toolkit. Firstly, we considered the models and extensions that constitute the theoretical foundations of technology acceptance, including the TAM (F. D. Davis et al., 1989), TAM2 (Venkatesh & Davis, 2000), TAM2' (Venkatesh, 2000), TAM3 (Venkatesh & Bala, 2008), UTAUT (Venkatesh et al., 2003). Secondly, we included models focusing on pervasive technologies: UTAUT2 (Venkatesh et al., 2012), and PTAM (Connelly, 2007). Thirdly, we incorporated acceptance models developed specifically for the healthcare context: HITAM (Kim & Park, 2012), Hsu et al.'s model (C.-L. Hsu et al., 2013), Dou et al.'s model (Dou et al., 2017), Cheung et al.'s model (Cheung et al., 2019), Schomakers et al.'s model (Schomakers et al., 2019), and Dhagarra et al.'s model (Dhagarra et al., 2020).

Table 4.1: The user acceptance antecedents covered by the TAC cards, organised by category, with their definition and origin models.

Factors	Definitions	Models
Health		
Health status	Whether one “has any diseases or comorbidity” (Kim & Park, 2012, p. 3).	(Kim & Park, 2012)
Health beliefs and concerns	Perceived susceptibility and issue severity (Hochbaum et al., 1952).	(Kim & Park, 2012; Cheung et al., 2019).
Healthcare professional relationship	Trust in clinician to deliver accurate health information, and help seeking behaviour (Dou et al., 2017).	(Dou et al., 2017)
Individuality & Social context		
Demographics	Gender, age, socio-economic status (Venkatesh et al., 2003, 2012; Connelly, 2007).	(Venkatesh et al., 2003, 2012; Connelly, 2007)
Resistance to change	“People’s attempt to maintain their previous behaviors and habits in the face of change required” (Dou et al., 2017, p. 3).	(Dou et al., 2017)
Self-image	“The degree to which use of an innovation is perceived to enhance one’s image or status in one’s social system” (G. C. Moore & Benbasat, 1991, p. 195).	(Venkatesh & Davis, 2000; Venkatesh & Bala, 2008)
Social pressure	“The perceived social pressure to perform or not to perform the behavior” (Ajzen & Madden, 1986, p. 454).	(Venkatesh et al., 2003, 2012; Kim & Park, 2012; Connelly, 2007; Cheung et al., 2019)
Perceived social support	Facilitating conditions, or “the availability of resources needed to engage in a behavior” (Taylor & Todd, 1995, p. 139).	(Venkatesh, 2000; Venkatesh & Bala, 2008; Cheung et al., 2019)
Technology		
Technology anxiety	“The fear or apprehension felt by individuals ... when they considered the possibility of computer utilization” (Simonson et al., 1987, p. 238).	(Venkatesh, 2000; Venkatesh & Bala, 2008; Kim & Park, 2012)
Perceived reliability	<i>Output quality</i> (“how well the system performs [required] tasks” (Venkatesh & Davis, 2000, p. 191)) and <i>Result demonstrability</i> (“tangibility of the results of using the innovation” (G. C. Moore & Benbasat, 1991, p. 203)).	(Venkatesh & Davis, 2000; Venkatesh & Bala, 2008; Kim & Park, 2012)
Technology playfulness	“The degree of cognitive spontaneity in microcomputer interactions” (Webster & Martocchio, 1992, p. 204).	(Venkatesh, 2000; Venkatesh & Bala, 2008; Kim & Park, 2012)
Technology enjoyment	“The extent to which the activity of using a specific system is perceived to be enjoyable in its own right” (Venkatesh, 2000, p. 351).	(Venkatesh, 2000; Venkatesh & Bala, 2008; Kim & Park, 2012)
Privacy protection	“Concern for loss of privacy and need for protection against uncalled-for communication and misuse of personal information” (Dhagarra et al., 2020, p. 3).	(Schomakers et al., 2019; Dhagarra et al., 2020; C.-L. Hsu et al., 2013)
Trust	belief that “the healthcare provider [will] fulfil [the patient’s] needs” (Dhagarra et al., 2020, p. 4).	(Dhagarra et al., 2020)
Objective usability	Construct allowing to “compare different systems using objective measures of usability/system characteristics” (Venkatesh & Davis, 1996, p. 457).	(Venkatesh, 2000; Venkatesh & Bala, 2008; Kim & Park, 2012; Dou et al., 2017)
Integration	“How well the technology is integrated into our lives” (Connelly, 2007, p. 4)	(Connelly, 2007)

Identifying the Key Concepts across the Selected Models

In order to ground discussion among designers in pragmatic terms pertinent to real-world design choices, we chose to focus the TAC cards on antecedent factors (also referred to as external variables or determinants), representing explanatory variables impacting user acceptance (see Chapter 2 Section 2.3.2). Table 4.1 provides a complete overview of the 16 antecedent factors included within the final TAC card deck, along with their definitions, and the models from which they originated. To maintain a clear focus on the context of health, we additionally excluded those constructs highly particular to the use of technology for work (e.g. *job relevance* (Venkatesh & Davis, 2000; Venkatesh et al., 2003)). Where models overlapped, similar constructs were regrouped as a single unique factor to facilitate their inclusion. *Reference group influence* (Cheung et al., 2019)) and *Voluntariness to use* (Venkatesh & Bala, 2008; Venkatesh & Davis, 2000; Venkatesh et al., 2003)) were, for example, regrouped under *Social pressure*.

Developing the Cards' Textual and Visual Content

Each card comprising the TAC deck was designed to represent a single antecedent factor of technology acceptance, depicted on the front side of each card in the form of a title and icon combination, intended to support memorability and the ability to easily distinguish cards from one another (see Fig. 4.1). Following both the common user acceptance literature practice of categorising acceptance factors (Kim & Park, 2012; Dou et al., 2017), and Alkhuzai and Denisova's design card heuristics recommending the grouping of cards and use of colour to differentiate groups (Alkhuzai & Denisova, 2021), we created three colour-coded categories pertaining to Health (red), Individuality & Social context (orange), and Technology (blue), and associated each of the 16 TAC factors to the category that related to their definition. For instance, the *social pressure* factor presented in Figure 4.1 was placed in the Individuality & Social context category. By means of this categorisation, we aimed to facilitate familiarisation with the cards, as well as the learnability of the 16 acceptance factors.

Inspired by previous work in relation to the value of sensitising concepts (Sas et al., 2014) and interaction design tools aimed to make frameworks, such as that for tangible interaction more accessible (Shaer & Hornecker, 2010), we also developed thought-provoking, sensitising questions pertinent to each factor — displayed on the back of each card. While the first question (in bold) at the top conveys the factor's definition in an accessible manner, the sub-questions encourage deeper reflection on the different aspects of the definition. Some cards also contain a 'bonus' question, which is less theoretical and more design-oriented in nature, in order to further help bridge the gap, for designers, between theory and practice. The cards were themselves designed to resemble playing cards in support of users' engagement (see the full deck of TAC cards in Appendix A).

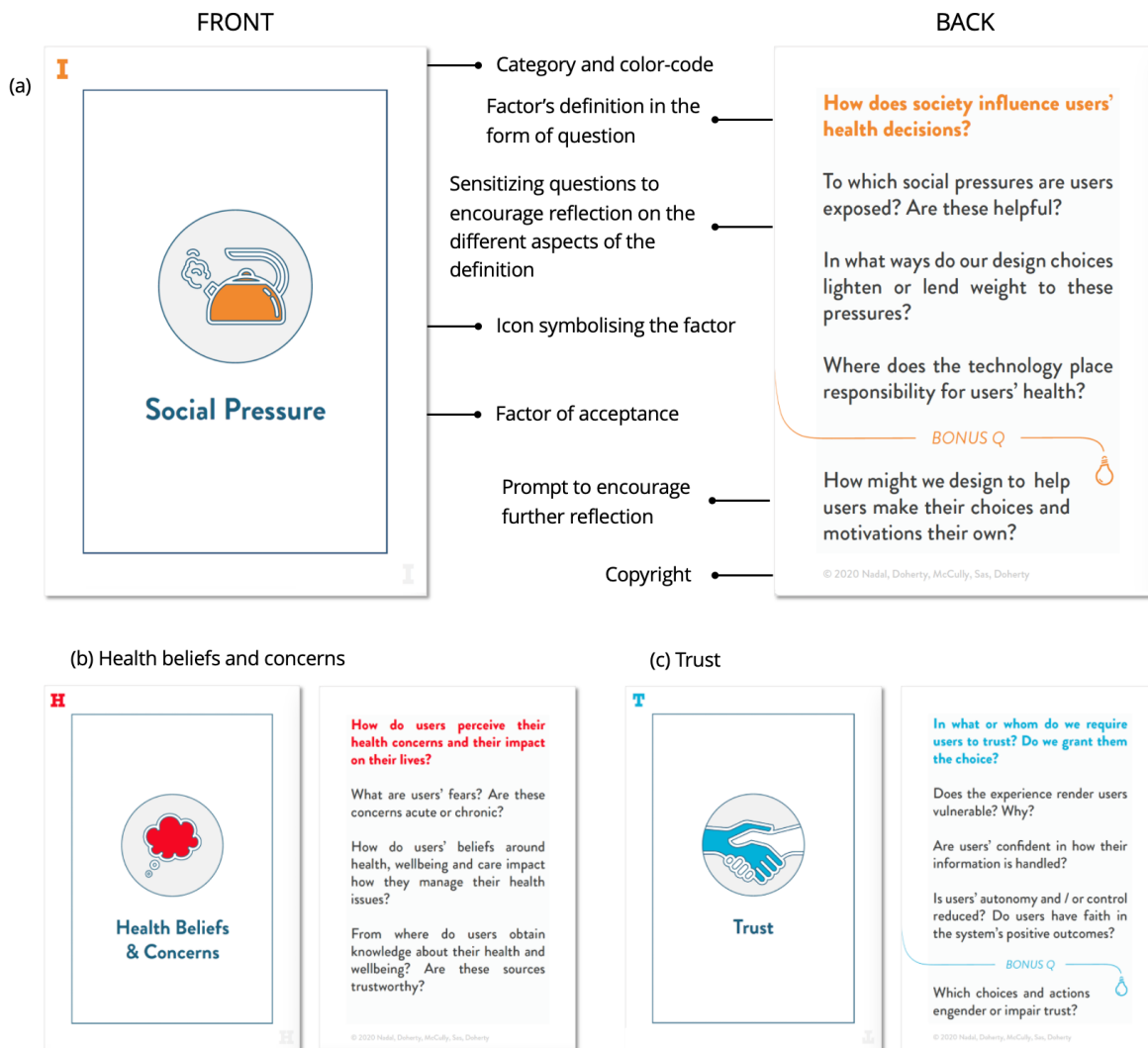


Figure 4.1: Examples of TAC cards showing on front antecedents of technology acceptance: *Social pressure* (a), *Health beliefs and concerns* (b), *Trust* (c), and on back sensitising questions.

4.2.2 Crafting the TAC Context

Envisaged for use primarily as an exploratory design method early in the design process, we adopted the use of personas and scenarios as means of crafting a realistic context for reflection on technology acceptance of persons receiving health or mental health care. These fictional personas and scenarios enable us to explore one possible use of the TAC cards in the process of design. In particular, we introduce a novel type of scenarios — which we call *temporal multi-choice scenarios* — providing an example of implementation of the user acceptance journey. We recommend that designers wanting to use the TAC toolkit, in design activities with personas and scenarios, create their own materials exploring the different stages of the user journey.

The TAC Personas

Through iterative collaborative design, we developed three personas, each associated with a respective scenario. While designing these personas, we aimed to ensure diversity of age, gender, and health concern, creating three fictional characters living with common yet diverse health issues, for which technological

solutions are often offered. These include Ella, a young woman and trainee solicitor newly diagnosed with type 2 Diabetes; Ali, an elderly bereaved spouse and retired florist, prescribed and struggling to manage antidepressant medications; and Alex, a middle-aged bus driver and father of three, worried about the possibility of catching COVID-19 and passing it on to his family. Each persona included demographic information such as age, occupation, health status, social context, and experience with technology, as well as information on the challenges they faced, and personal traits that may influence the character’s acceptance of technology (see the three TAC personas in Appendices B.1 – B.3).

The TAC Scenarios

In parallel with these personas, we additionally developed three scenarios designed to inspire engagement with the unfolding of each persona’s *interaction trajectory* with a pertinent technology, namely a glucose monitoring sensor and app (Ella, Diabetes), medication reminder app (Ali, depression), or governmental contact tracing app (Alex, COVID-19). The three TAC scenarios can be found in Appendices B.1 – B.3.

To account for the evolving nature of user acceptance over time, we emphasised the macro-temporal perspective of technology acceptance by drawing inspiration from the TAL timeline (proposed in Chapter 3 Section 3.3.4). Each scenario was therefore structured in terms of the three consecutive stages of *pre-use acceptability*, *initial use acceptance*, and *sustained use acceptance*. The *pre-use acceptability* stage encompasses the period before any interaction with a technology occurs, but when both awareness and contemplation of its use surface. Thus, drawing also from previous work, two specific and critical temporal milestones in this stage were identified as *seeking advice*, described as a critical step in an individual’s health trajectory (Pretorius, McCashin, Kavanagh, & Coyle, 2020), and *choosing technology*, or the decision to start using a health technology (Szinay et al., 2021). The very first interaction with a technology marks the end of the *pre-use acceptability* stage, and the beginning of *initial use acceptance*. Here, to facilitate exploration of a more granular time scale, we considered the three temporal milestones of *first interaction*, *next day*, and *a week later*. Finally, in the last stage of *sustained use acceptance*, we considered the following temporal milestones: *after 1 month*, *after 3 months*, and *after 1 year* — the first two of which have been suggested as milestones for long-term acceptance in previous work (Venkatesh & Davis, 2000), while the last was added to reflect the lengthy or lifelong nature of many health conditions. These 8 temporal milestones are presented alongside the TAL timeline in Figure 4.2.

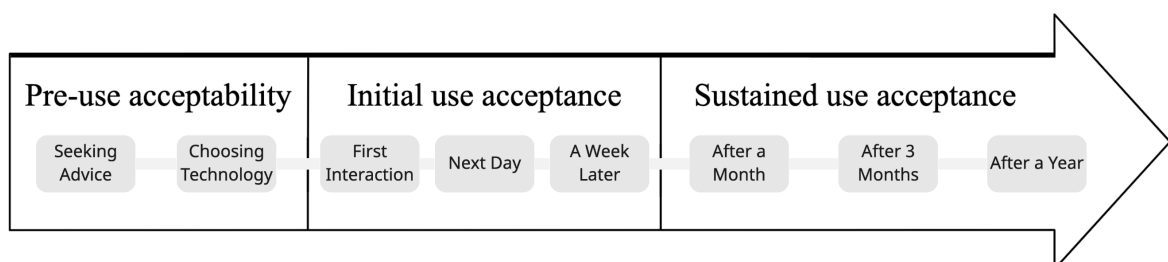


Figure 4.2: Scenarios’ temporal milestones, alongside the 3 stages of the Technology Acceptance Lifecycle.

To support richer designer engagement, we further identified and described for each specific milestone, three choices or paths, each recounting acceptance issues of either high, medium or low degree of challenge. For this, we drew inspiration from interactive narratives (Andrews & Baber, 2014), where multi-choice scenarios have been used instead of linear sequence stories or traditional linear scenarios. Figure 4.3 shows the scenario for persona Alex. Each of the 8 temporal milestones presents 3 paths, each exploring acceptance issues of high, medium or low degree of challenge.

Nodes	Neutral path #1	Neutral path #2	Neutral path #3
SEEKING ADVICE	We were watching the news when. The Minister for Health was on the news explaining how important "contact tracing" app is in terms of dealing with this whole COVID thing. They were talking about how important this is for us to download it, how it's fully GDPR compliant, we can opt out whenever etc etc. Seems important.	I talked to the family. We were having dinner, chatting & once again COVID was the topic of conversation. They're worried about me coming into contact with it working the bus route, and to be honest, so am I - especially with my heart. My son asks if I have downloaded the contact tracing app. I mention I have some hesitations, privacy and all that, but he walks me through it.	I was on the internet. I've seen a lot of people talking about this "contact tracing" app on Twitter in the past few days, not all positive. There's been a bit of chat in my WhatsApp groups about it - which is far from peer-reviewed I know - but still, I've got some apprehensions about it. The health minister tweeted a series of videos explaining how important contact tracing was to the public effort.
CHOOSING TECHNOLOGY	There it was, in the AppStore. When I logged on to Twitter this morning the first Ad in my feed was from the government, for this contact tracing app. I was going to download it anyway, but decided to click in straight away and get it downloaded before I forgot.	It was on the boss's orders. We all got an email in work from the head office. They have insisted we download the COVID tracker app if we want to stay on the job. I would have probably done it anyway but still, the role is public facing & public sector so I can see why. Went onto the App Store and downloaded it.	We were chatting over dinner. COVID has been the main topic of conversation at our dinner table lately. I ask my son about this contact tracing app, tell him some of my hesitations - what I've been seeing in my WhatsApp chat. He's a bit more turned into this tech stuff. Says it's WhatsApp I should be worried about, not the contact tracing app - especially with my condition. He walks me through it a bit more, even downloads it for me.
FIRST INTERACTION	 High severity path Is this thing working? Downloaded it from the App Store but it doesn't seem to be right. It downloaded fine but when I try to open it I get some warning about "device compatibility". I haven't gotten a new phone in a few years, I think I might have to upgrade.	 Medium severity path I've heard it's a big drain. Downloaded it from the App Store, all it needed was my phone number to set up. It requires bluetooth to be on - all the time. I'm a bit worried about it draining my battery if it's on all day.	 Low severity path Well, that was easy. Downloaded it from the App Store, seemed simple enough. It needs my number & my location. It has all the information about the country's cases, regional case breakdown etc. I had to "opt-in" for the contact tracing feature so that I'll get a notification if I'm near a confirmed case. Still somewhat hesitant, privacy wise, but given the situation, I think this is more important.
NEXT DAY	I'm lost in the settings. I thought I had it set up correctly but after talking to a friend at work about it, I realised I didn't "opt-in" for the contact tracing. I'm a bit lost in the settings to be honest, but I think I have it turned on now.	My battery seems low. I "checked in" this morning before work. No symptoms obviously. I charge my phone overnight and it generally lasts me all the next day, but my battery was at 20% by lunch today. It must be the tracker app, I've heard it's a big drain.	It only takes me seconds. Checked in this morning and that was it really. Over and done with in a few taps. It has information about the country's cases & stuff but other than that, there's not much to it.
A WEEK LATER	I was really worried when I saw the notification. I got an "exposure notification" yesterday. Apparently I had been in close contact with someone who tested positive - the only thing is, I've been off work the last two days, I haven't left the house I was thinking maybe it was a family member but none of them have gotten the same notification. I have no symptoms but I called my doctor regardless. Not too confident in the app at the moment.	I think I need a new phone. I bought a new phone. My old one wasn't compatible and now is as good a time as any to upgrade I suppose. The app is set up on my new phone & seems to be working fine. I check in once a day & haven't gotten any notifications.	I use it once a day and then forget about it. I check in once a day & haven't gotten any notifications. It doesn't bother me & I've been encouraging those around me to download it.
AFTER A MONTH	I got tested. Initially I thought I was overreacting, slight cough, bit of a headache etc. But as soon as my taste & smell started to go I knew something was wrong. Thankfully I had been off work. Got tested 3 days ago & have been quarantined ever since. The doctor asked me if I had the app & then asked if they could put in a code to notify close contacts. I said yes, it was the least of my concerns. Quarantined in the spare room, slightly worried.	I picked up a power bank. I had to buy a power bank for my phone. Having my bluetooth on all day was draining my battery too much. It's quite annoying & clunky.	I barely notice it. It's routine now, I check in over breakfast each morning, close the app & forget about it. Haven't gotten a single notification.
AFTER 3 MONTHS	It keeps crashing for me. I don't know if it's my phone or the app but it crashes everytime I try to check in. I've kept the app because it has up-to-date information about the number of cases in the country but I'm not sure how much good I'm doing by having it if it doesn't work as intended.	I haven't thought of it much. I've forgotten about it to be honest. It's useful for the case data but that's on the news most evenings & I don't know how much I need to hear daily cases if we just have to live with this COVID situation. It's overwhelming. I don't usually check in but I keep the app just in case I get a close contact notification.	I got a worrying notification. I got a notification last week that I had been in close contact with someone who tested positive. Given my work on public transport, it's not surprising. It was quite worrying to be honest. I thought "if I have it, then the rest of the family do as well, not to mention everyone at work". I would hate to be the one to have given it to family & friends. Everyone at home felt fine but we got tested regardless. Negative thankfully, but those were a stressful few days regardless!
AFTER A YEAR	I don't think I need it. We haven't had a community transmission in 6 months. The threat is still there but life has returned to normal - more or less. I got a new phone a few months ago & didn't bother to download the contact tracing app.	It's no hassle to keep it. I kept the app on my phone & checked in every day for a while, gradually less & less, and now I don't use it at all to be honest but things are a lot more under control at the moment. We haven't had a community transmission in 6 months, the threat is still there but life goes on. Still hesitant with regards to sharing my location constantly but it's a small price to pay considering the national risk.	I'm glad I used it. I'm glad I downloaded it to be honest! The family had a couple of scares where we got close contact notifications and had to get tested. Having the case numbers was handy but probably a bit too much information at times. Thankfully we've all managed to stay healthy.

Figure 4.3: Temporal multi-choice scenario for Persona Alex (COVID-19).

The milestones of *seeking advice* and *choosing technology* – situated before technology use – present three neutral paths, as acceptance issues are yet to arise. For the purpose of the workshop examining use of the toolkit to design for acceptance across the user journey, each scenario presented a case where the persona took on the technology. However, there might be value in exploring scenarios where *pre-use* milestones present issues of acceptability, in order to identify elements that might prevent uptake of the technology. Thus, at each temporal milestones, designers can choose from three different paths the one they prefer to explore.

Design tools fostering empathy have long acknowledged the value of scenarios, in the mental health con-

text in particular, from video stories (Honary, McNaney, & Lobban, 2018) to vignettes, as means of describing the lived experience of ill health (Sas, Hartley, & Umair, 2020), or supporting therapeutic role-play (Matthews et al., 2014). To further elicit empathy in this case, both personas and scenarios were written in the first person, employing believable, colloquial language. Lastly, we aimed to elicit empathetic engagement through role-play, as previously employed to support the design of health technologies (Matthews et al., 2014).

4.2.3 Devising the TAC Process

The final step to complete the TAC toolkit was to give designers a space to collaborate and interact with the TAC cards, personas, and scenarios. This space takes the form of the TAC think-space, and is complemented by a companion website.

The TAC Think-Space

To provide a space for participants to work collaboratively with the TAC cards in relation to particular design problems, we created a virtual board, using the online platform Miro (Miro, 2021). This think-space enabled participants to interact with the TAC cards in virtual analogue form, displaying their front side only, in a collaborative digital space, at the same time as interacting with the physical deck. The think-space allowed designers to place selected cards against each temporal milestone of the user journey, while making notes reflecting their decision-making to the side. Figure 4.4 presents the think-space used by Group 5, as it stands after the workshop. The think-space for each group followed a similar template including the 3 stages of user acceptance (top), a space for participants to select cards for the 8 temporal milestones (middle), and the 16 TAC cards colour-coded by categories (bottom).

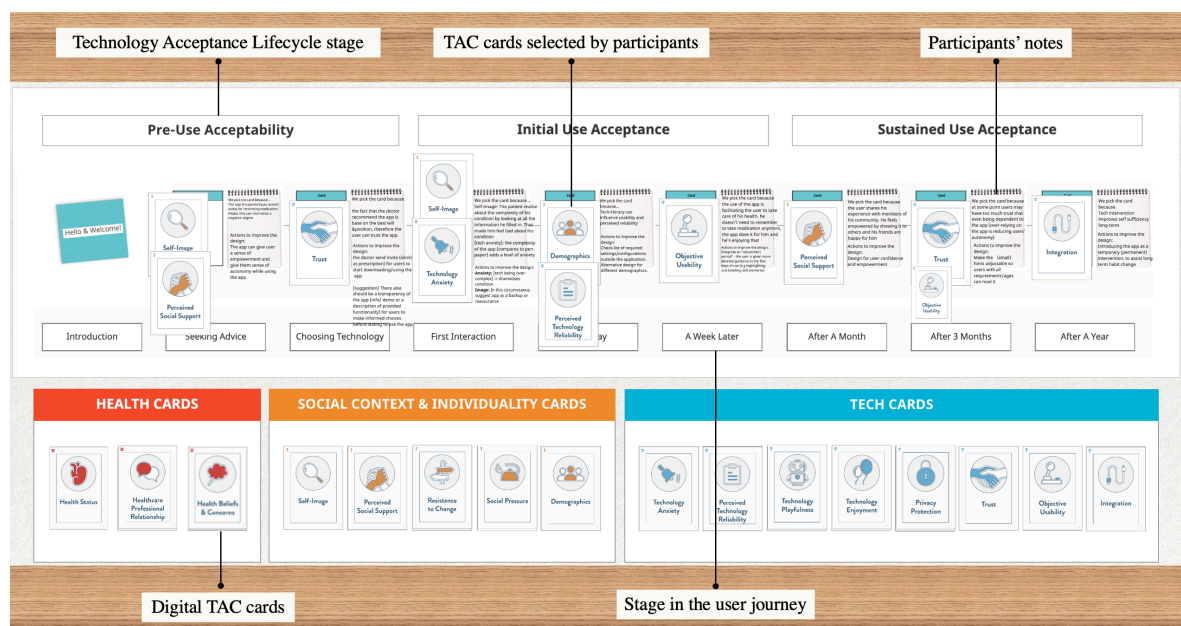


Figure 4.4: Think-space used by Group 5, as it stands after the workshop.

Finally, as multi-choice scenarios can be more effectively implemented digitally, we also developed the TAC interactive website (Nadal, McCully, Doherty, Sas, & Doherty, 2021) to host the digital personas and scenarios (see Fig. 4.5).

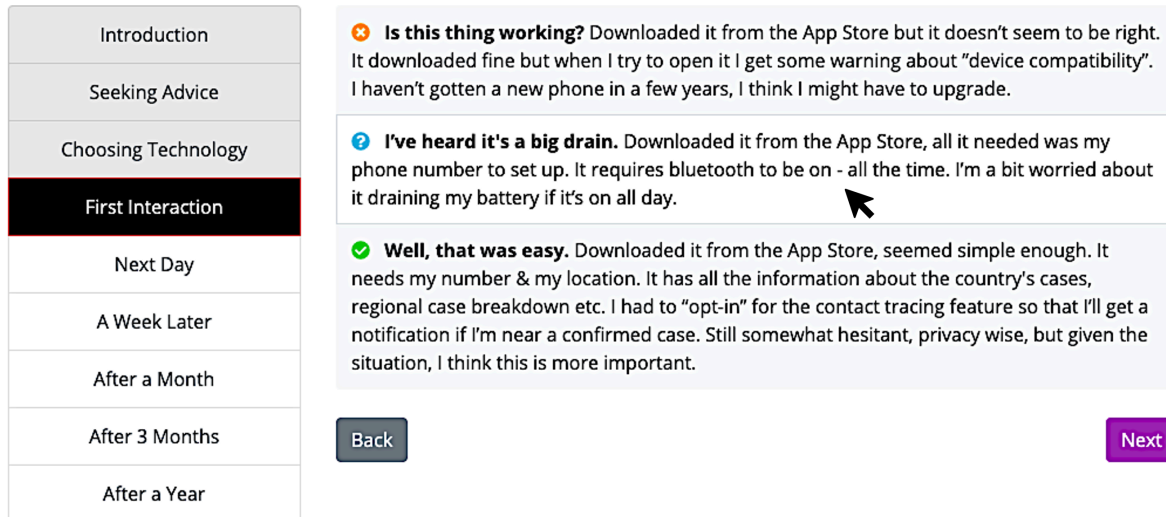


Figure 4.5: Scenario view for the persona Alex (COVID-19). The current step is 'First interaction', with three possible paths for the event of first launching of a government contact tracing app.

4.3 Evaluating the TAC Toolkit

We designed a study to support evaluation of the TAC toolkit as a novel exploratory design tool, with the aim of gathering insight into designers' experiences of using the toolkit, and perceptions of its value for designing for user acceptance of health technologies.

4.3.1 Participants

We recruited designers of health and mental health technologies through our personal and professional networks, as well as Twitter postings (see flyer used in Fig. 4.6). Participants were deemed eligible if over 18, proficient in English, and currently actively designing digital health or wellbeing interventions. The study was approved by Trinity College Dublin Research Ethics Committee, and designers received a £20 Amazon voucher for their participation in the workshop ($\approx 1\text{h}30$) and follow-up interview ($\approx 30\text{min}$).

Participants' ages ranged from 25 to 34 (17), and 35 to 44 (4). Ten identified as female, 10 as male and 1 preferred not to disclose. Most originated from within the EU (15), and all were working in Europe: 14 in academia (4 with prior industry experience) and 7 in industry; 16 in the design of mental health technologies, 5 in health, and 3 in both. We also sought to recruit individuals with diverse backgrounds to reflect the interdisciplinary work of designing health technologies, resulting in a diverse range of participants specialising in HCI (8), clinical psychology (4), design (4), HCI and psychology (2), biomedical engineering

(2) and software engineering (1). Two participants (P16 & P20) had encountered certain acceptance theories in their work; the remaining 19 participants disclosed no previous experience with user acceptance theories.



Figure 4.6: Flyer used for participants' recruitment on Twitter.

4.3.2 Methods

We chose to evaluate the TAC toolkit through workshops to allow groups of designers to engage in collaborative design in a realistic manner. Prior to the workshops, the 21 recruited participants were divided into groups of three. Each group included at least one person with a background other than HCI, in order to simulate the diversity of expertise typically encountered in real design teams. The 7 workshops took place as Zoom sessions, supported by a single facilitator. At the start of each session, the participants read the study information sheet, provided digital consent, and answered an online demographic survey. The facilitator then described the purpose of the workshop (i.e. evaluating a new tool to design for user acceptance), and confirmed that all participants had access to both the physical and digital materials. Following these introductions, the facilitator explained that one person in the group would play a fictional user facing health or mental health difficulties, in the form of a persona to-be-selected, while both others would play the role of designers. Each group decided among themselves who would take on that role — a choice made to strengthen users' ownership of the scenario and process. In particular, having one participant in each group role-playing a persona could better support group's emotional and cognitive empathy for the persona's issues of technology acceptance. Thus, we designed not only the TAC toolkit but also the method for using it involving role-play. Once roles were claimed, the workshop then proceeded following the 9 steps described in Figure 4.7; the two designers and single user attempting to (i) expose technology acceptance issues while traversing and actively shaping the persona's narrative throughout the user journey, and (ii) discuss possible design actions in response to these issues.

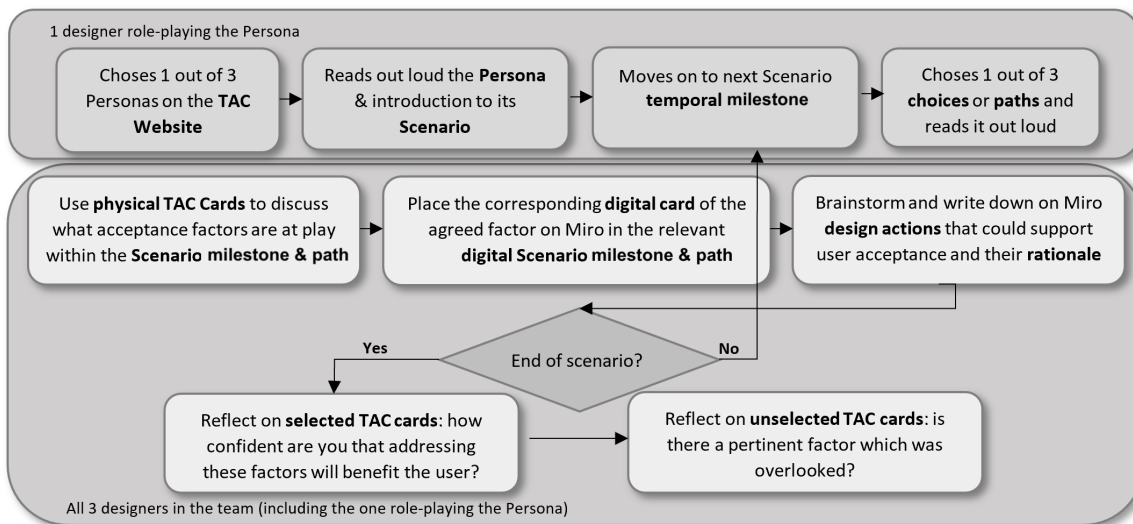


Figure 4.7: Workshop procedure showing the 4 activities performed by designers role-playing the persona (top) and the 5 performed by the design team (bottom).

For instance, at the *first interaction* step presented in Fig. 4.5, Group 2 wrote “*Difficult user on-boarding caused significant friction for first use*” and the design action “*Easy phone check in advance to check if it [the app] will work*”. Following the workshop, each participant took part in a 30-minute semi-structured interview, during which they were asked about their experience and perceptions of the different elements of the toolkit: the TAC cards and their sensitising questions, persona and scenario, think-space, website, and role-play as method employed during the use of the toolkit (see interview guide in Appendix C).

Hybrid Materials: Combining Digital Elements with Physical Cards

Each of the seven groups of designers was given remote access to the Miro board (think-space) where they could collaborate for the duration of the workshop. The designer playing the role of the persona was granted access to the TAC website to choose their persona and interact with the multi-choice scenario. Each participant was also provided the physical deck of TAC cards, which was mailed to them beforehand. The traditional design context entails the co-located presence of designers and other stakeholders in the same room. During the COVID-19 pandemic however, many designers had to change the ways in which they practice and participate in design. Although public health restrictions imposed the evaluation of the TAC toolkit to be carried out remotely, we sought to draw on insights from previous research highlighting how cards’ physical form can prove key to facilitate communication of ideas, supporting collaboration, and fostering creativity (Lucero, Dalsgaard, Halskov, & Buur, 2016). For this reason, we chose to deliver to each participant a physical deck of the TAC cards, for use in combination with the digital versions during the workshop. While this decision was motivated by the consequences of COVID-19, the hybrid nature of the workshop came to form an important component of our process.

4.3.3 Data Analysis

Each workshop and interview was audio recorded, totalling over 20h of audio, including 9h42m (an average of 1h23m per group) from the workshops, and 10h50m (an average of 30min per participant) from the interviews. These recordings were anonymised and fully transcribed. Our approach to the data analysis comprised both inductive and deductive thematic analysis. First, an inductive thematic analysis of workshops and interview transcripts was conducted following Braun and Clarke's approach (Braun & Clarke, 2012). This process entailed successive readings of the transcripts and familiarisation with the data, complete coding of the data, pattern identification and analysis, definition of themes, and reporting of findings. Then, a deductive thematic analysis of the same dataset was conducted, focusing specifically on the temporal dimension of participants' experiences with the TAC toolkit, and grounded in the factors of the TAL model. Finally, each group's completed think-space board was captured, and examples extracted to illustrate and further support results of the thematic analyses.

4.4 Findings | Inductive Thematic Analysis

Inductive thematic analysis of these 7 workshops and 21 interviews provided insight into participants' actual and possible future use of the TAC toolkit, including in particular its value for bridging theory and design practice, and for fostering richer conversations and reflection on users' acceptance of health and wellbeing technologies.

4.4.1 Bridging Acceptance Theory and Design Practice

One of our primary aims in designing the TAC toolkit was to help bridge theory and practice for the design of health technologies that account for users' acceptance. Findings from both workshops and interviews highlighted the threefold value of the TAC toolkit in such bridging through (i) challenging designers' pre-conceptions about technology acceptance and extending their understanding, (ii) motivating the application of technology acceptance theory through role-play, and (iii) shaping designers' actions to better account for user acceptance.

Challenging Designers' Preconceptions about Technology Acceptance

It was through challenging participants' preconceptions of acceptance that the impact of the TAC toolkit was rendered most visible. In particular, designers commented often on the role of the toolkit in challenging a commonly-held assumption that the question of acceptance ceases to prove relevant once the user begins using the technology: *"You made me realise that, you know, you have to consider acceptability at different points and that this acceptability may change because the needs of the user may change over time"* (P14). Participants spoke then of coming to conceive of **acceptance as a dynamic process**, in line with the underlying

theory reviewed in Chapter 2. A participant with some prior familiarity with existing models of acceptance, explained: “*It definitely makes you think about the technology [as] less static ... something that needs to kind of grow and continue with this person and their needs*” (P20). This quote suggests renewed awareness of the value of exploring acceptance across the entire user journey. In turn, this can foster sensitivity towards the design of complex technologies, required to accommodate evolving users’ needs.

Responses additionally highlight that the toolkit’s timeline and cards’ three categories gave designers a means to visualise this transformation of users’ needs. For example, on reviewing their final think-space board, P17 noted that “*it is quite interesting how the ‘social context’ is at the beginning, and then the ‘health’ cards are at the beginning and end ... and the ‘technology’ cards are all over [the user journey]*”. This reflects an understanding of acceptance as extending beyond the *pre-use* stage, and indicates an emerging practice among designers of **linking the process of acceptance to the user journey**: “*It really helps to re-focus the design in a user-centred perspective all along, and going from the short [term] ... to the use and adoption of the device in long-term*” (P9). This key finding suggests heightened awareness of evolving use and user acceptance over time, further reflected in P14’s comment on the importance of **accounting for the possible evolution of user needs**: “*when people are using it [the system], maybe we forget that we still need to make some adjustments*”.

Some designers also reported that **acceptance issues began to feel even more concrete** in the later stages of the user journey, where the issues are “*tangibles, whereas in the beginning there’s still a lot of too many [sic] intangibles*” (P18). This was an impression further accentuated by the role-play element of the scenario: “*It hits you on the personal note towards the end, more so than the beginning. ... It becomes more personal because I’ve now invested a year in this thing [technology]*” (P5, playing the persona).

These moments of insight pertained not only to the concept of user acceptance in a broad sense, but also to the nature of health technologies in particular. This was highlighted by P1, a designer with mixed HCI and psychology background, who pointed out that designing healthcare technologies was a complex process “*with lots of different stages, and different stakeholders*” and that therefore, the path to acceptance was likely to be longer than for other technologies.

Finally, engaging with the TAC cards during these sessions appeared often to **nurture designers’ appreciation for, and challenge their understanding of acceptance factors**, in particular leading them to develop a richer understanding of their definition and interaction, through reflection on the cards and conversation with other participants. P11, for example, speaking of the factor of ‘trust’, explained coming to understand that “*it is not only about ‘trust’ as in ‘the data is safe’, but there’s also other aspects that we should consider*”, referring to the workshop discussion.

Extending Designers’ Understanding of Technology Acceptance

The TAC toolkit also expanded designers’ perspective on user acceptance, shining light on factors that some wouldn’t have considered otherwise: “*I hadn’t thought about all those forms of acceptance before, I think particularly the social ones*” (P5). The **number of factors influencing acceptance** was also a surprise for many

designers: *“I would never have thought of that many factors at play”* (P6) and *“I was not familiar with all these factors ... My spectrum and my way of speaking changed around that topic”* (P21).

Selecting **positive user stories** during the multi-choice scenarios made some designers realise that, even when ‘all is going well’, there may still be room for improvement in terms of user acceptance. As P14 commented that even if *“everything went well, still there was a bone that you could try to address”* — a point also reflected in Group 2’s notes on the think-space *“The user seemed to be enjoying/accepting the app enough to be prompting friends to install it. [Design action:] Include easy sharing mechanic to allow viral spread”*. A participant reflected on how *“designers are trained to look at barriers”* while there is value in amplifying positive elements: *“I like the idea of choosing some of the positive stories ... we can think about how could this ‘social support’ or ‘enjoyment’ of the technology be amplified”* (P1).

The multi-choice scenarios also helped designers **picture the range of possible user experiences**. P17, for instance, who was playing the persona and therefore had to pick a path at each scenario step, described how *“it’s quite interesting to see the different sorts of people that you may find”*.

Although real-world acceptance issues often **involve a mix of factors**, we initially asked participants to pick only one card per scenario step, to encourage negotiation and deeper conversations within groups. This choice aimed to harness the principle of trade-off-driven design (Blackwell & Green, 2003), previously suggested to help participants select and discard cards as needed (Mueller et al., 2014). While discussing cards for the first step however, all groups asked if they could select several cards, as they felt one wasn’t sufficient to cover the factors at play. The facilitator then informed participants that they could pick multiple cards if they felt several factors were involved. We provided designers this autonomy during sessions in order to avoid creating an overly artificial study context. P20 commented: *“if we’d only picked one, then maybe some important things wouldn’t have been considered ... we’d never have ‘privacy protection’ in there”*.

Several group discussions revealed close relationships among factors, and their negotiation. For example, Group 2 discussed the interplay between ‘social support’ and ‘social pressure’ — *“This support through pressure ... It’s like the strategy to provide the ‘social support’ is ‘pressure’. It’s why it feels so entwined”* (P5) — and wrote on the think-space *“Social pressure/support deemed equivalent in this case. The app was installed due to a social interaction”*. Participants additionally spoke of and leveraged the **positive vs negative impact** of acceptance factors — *“Before it was a lack of ‘trust’ and now it’s too much”* (P13) — and suggested making this positive/negative outlook more visually explicit in using the TAC cards by, for example, flipping the card upside down on the board (Groups 1 & 2).

Participants also came to recognise developing an accurate understanding of users’ needs as a less than straightforward process. They did comment however that the TAC cards **helped identify users’ needs**: *“I feel like users are very complex and it [the cards] were helping me maybe see the nuances in between”* (P17), by *“facilitating a faster understanding of what are the main targets, the main things to design for”* (P11). A developer commented, *“it’s hard to design for a person as opposed to for a person’s needs”* (P4), further explaining that the cards allowed them to *“turn this user into a set of experiences and actions”* in order to find *“the set of steps to solve this [acceptance] problem”*.

Motivating the Application of Acceptance Theory through Playfulness

During interviews, the physicality of the cards was continually raised as a positive aspect of participants' experience. In particular, most participants enjoyed the playfulness of the TAC toolkit and compared it to a game: *"It felt like playing a board game, because the physical cards, the notion of placing things, the notion of choosing ... gave a tactile nature to it that I really liked"* (P4). We observed that this **playfulness encouraged designers to apply acceptance theory into practice**. P4 explains how the physicality of the materials made it feel as if they were 'solving a mystery': *"Holding the cards, but in a way that the cards are telling a story ... The mystery is how do we improve the user's journey with an app?"*.

The challenge of determining the influencing factors at each of a scenario's temporal milestones made the task meaningful and engaging: *"It felt almost like we were trying to find the right answer. Even though there is no right answer, that's not the point"* (P3), and additionally highlighted **designers' understanding that there is no exact truth** — in that the factors selected depended upon designers' interpretation of the scenario. Finally, participants felt **satisfaction at being able to leverage the complex issue** of acceptance, *"touch[ing] on kind of the core components of a really complex problem and tech solution"* (P7).

Supporting the Negotiation of Acceptance Factors

The physical externalisation of the selection process was mentioned as something that particularly **helped participants determine which acceptance factors were, or were not, relevant** to a given scenario: *"I like physical stuff to touch, move around ... To say 'this card does not apply', I'm literally physically gonna put it over here behind my monitor and not look at it"* (P3). This decision-making was supported by **an easier comparison process**, commonly reported as entailing two stages comprising orientation or familiarisation with the cards (Hornecker, 2010; Mueller et al., 2014; Bekker & Antle, 2011), and (re)framing of the problem space by selecting and discarding cards (Bekker & Antle, 2011). Participants would typically first quickly consider all of the cards, usually face up, before making an initial selection of 3 to 6 cards deemed relevant for the factor at hand. They would then turn the selected cards over, read the sensitising questions on the back, and discard the less relevant factors.

Some participants described arranging the cards spatially on their desk to prioritise the factors they judged most relevant to the scenario step: *"I had them [the cards] on the keyboard ... that gave me rows, and so I could put them forward and backwards ... to physically prioritise them"* (P4).

Finally, the tangibility of the cards was commonly reported as both helpful and refreshing in the context of the hybrid setting. In particular, **working with the physical cards appeared to encourage individual reflection** — allowing participants to examine the factors and form their opinion at their own pace, while also selecting those they felt relevant without being overly influenced by the other designer's choices: *"It frees your thinking when you have something tangible, and you're not just staring at a screen and other people, what they're picking out. I had my cards here in my hand. I felt quite free to pick as I wanted"* (P6). Instances of physical interaction, from displaying cards to the camera to shuffling cards in hand, were often observed

during the workshops — the combination of physical and digital appearing to render the experience more tangible and meaningful.

The sensitising questions on the back of the cards **helped designers (un)validate their intuition** about the acceptance factors at play, as reflected in a comment made during Group 5's workshop: *"I definitely think there's elements in the 'self-image' that is related to this situation, as in 'Might the technology itself carry a medicalising or even stigmatising effect?' [sensitising question]"* (P15).

Finally, the three categories (Health, Individuality & social context, and Technology) furthermore shaped participants' reflections in relation to acceptance at different points of the user journey. For instance, P17 (who played the persona) explained to their group: *"In this stage, my main worries are about the 'social context and individuality' because I don't think I'm thinking about 'technology' per se ... I don't think technology would be the first thing that comes to my mind"*.

Shaping Designers' Practice to better Account for Acceptance

During the interviews, designers mentioned a number of ways in which the TAC toolkit could shape their future design practice. Several participants explained that they would use the kit to **stimulate their own reflection on acceptance**: *"I will integrate [it] in my work now, not only design for a specific goal, but also really think about how this [technology] can be integrated in someone's life"* (P17). For P1 (with a background in psychology), the cards would be useful for *"think[ing] a bit more broadly about the technology side of things ... when I'm brainstorming"*. Other designers mentioned that **the cards helped them reflect on their own design practice**: *"I'm more aware of acceptance as a thing that I need to consider in design ... maybe use the cards to make sure I was really thinking of it"* (P20). Similarly, P6 (a clinical psychologist) commented that they would use the cards to **guide design conversations** in an interdisciplinary environment, by having *"these to hand in that kind of design phase to ensure that we're having the right conversations"*. This comment implies the need for tangible support to orientate discussion on user acceptance within interdisciplinary settings.

Finally, although the cards were initially framed for use by designers, several participants commented on the potential of the toolkit to **facilitate conversations with users** in two ways. First, it could support the elicitation of user needs: *"Maybe if you bring cards with examples, they'll start to think deeper about these factors, they'll realise 'Oh, this might actually be important for me, now that you've brought it up'"* (P10). Second, the TAC cards could be *"a really valuable way of measuring technology acceptance"* while acceptance models *"can be quite a complicated thing to even explain to someone [a user]"* (P16). It was suggested that the TAC cards might require several adjustments however to fulfil this aim of eliciting users' needs and to be successfully employed with users, such as *"mak[ing] a simplified version, perhaps for users, that has different questions"* (P1). An alternative approach, suggested by P3, was to employ the cards as a means of *'priming the conversation'* with users. Group 1's workshop provided an example of what leading a conversation with the TAC cards could look like, when Designer P2 asked User P1: *"Between 'health beliefs and concerns' and 'self-image' what do you think, Ali [persona], is more critical here for you?"*.

Adopting a More Ethical Approach to Design for Acceptance

Researchers have more recently also begun to acknowledge the association between technology acceptance and ethical design (e.g. in value sensitive design (Barn & Barn, 2018)), including *ethicality* as a factor in user acceptance — motivated in part by the acceleration towards digital healthcare driven by the COVID-19 pandemic, and the enforcement of governmental contact tracing apps (Paska, 2021; Perski & Short, 2021a; Tabourdeau & Grange, 2020). Paska, for example, argues that “*technology acceptance models should also take into account the ethical aspects of technology in terms of how technology shapes the image of today’s world*” (Paska, 2021, p. 2). Although the TAC cards didn’t include this *ethicality* factor, the workshop activities led designers to consider ethical principles while envisaging solutions to user acceptance issues.

At each scenario step, participants were asked to think of ‘design actions’ which might be taken to address the user’s acceptance challenges. A large number of the **design actions suggested by the groups were consistent with transdisciplinary ethical principles** developed by Bowie-DaBreo and colleagues (Bowie-DaBreo, Iles-Smith, Sunram-Lea, & Sas, 2020): *Transparency*, evoked by 4 groups (e.g. “*An indication of how reliable the [glucose sensor’s] results are*”, Group 4); *Autonomy*, mentioned by three groups (e.g. “*Allowing user to stay in control proactively (not reactively)*”, Group 3); *Accessibility*, recommended by two groups (e.g. “*Make the (small) fonts adjustable so users with all requirements/ages can read it*”, Group 5); And *Privacy*, discussed in one group (“*Notifications are general to protect privacy but detail in password protected app*”, Group 7). Finally, in line with the move towards more personalised health and mental health technologies, recommendations for more *tailoring* of the technology were made across four groups (Groups 3, 4, 5, 7).

4.4.2 Fostering Richer Reflections on Acceptance Concepts and Process

Participants discussed how using the toolkit changed their approach to reflecting upon user acceptance, through helping designers unfamiliar with the concept overcome obstacles to richer reflection, and encouraging new perspectives on user acceptance through interdisciplinary collaboration.

Facilitating Reflection around Acceptance

As our participants noted, multiple obstacles stand in the way of designers wishing to reflect upon and discuss user acceptance. First, technology acceptance is an ‘immense research field’ (P11), and the multitude of theories can prove overwhelming. By translating these theories into a relatively concise framework, the TAC cards **created a defined space for designers to approach theoretical constructs**:

« *I’ve come across 15 theories myself ... slightly different perspectives depending on the context ...
A set of kind of generalisable or standardised questions that could be asked for general constructs
that are suggested in those different theories, it’s a really useful tool to have.* » P16

Responses revealed that designers lacking familiarity with user acceptance refrain from taking part in design conversations if they feel they have ‘nothing to bring to the table’. The TAC cards created a safe

environment, **helping designers feel more confident in discussing acceptance**: “*I could be an important part of the discussion, on equal terms with the others*” (P11).

Another challenge for designers new to the concept of user acceptance is understanding the numerous individual aspects of acceptance: “*You have to remember that there could be all these different things at play*” (P1). The issue here is two-fold: on the one hand, designers might not remember all acceptance factors and fail to address key elements in technology design; on the other hand, they might overly focus on a subset of acceptance factors, and overlook others that might be relevant. In addition, trying to remember the theories adds to designers’ cognitive load.

While the TAC toolkit helps tackle these issues, we also observed the presence of a learning curve during participants’ first use of the cards, as reflected in P20’s comment that “*initially, it was a little overwhelming ... as time went on, you became more familiar with them*”.

The toolkit also served to **lend a concrete dimension** to the concept of user acceptance, often perceived as too abstract, by operationalising the acceptance factors in a form easier to grasp and apply in design: “*Without the moderation of the cards, when I think about user acceptance, well I think about it at a very abstract level ... it kind of helped navigate our thinking to one certain area in depth*” (P15). When participants were unsure about the meaning of a factor, **the sensitising questions at the back of the cards provided clarification** (P2). Similarly, when a factor’s name appeared too vague or ambiguous, designers checked their interpretation against the questions: “*My computer science brain obviously assumed ‘integration’ meant compatibility across technologies, but really it was ‘life integration’*” (P3).

Opening New Perspectives through Interdisciplinary Collaboration

The interdisciplinary setup of the groups also appeared to benefit designers’ reflection, as some participants reported that the collaboration shone light on relevant factors that they hadn’t considered: “*I could see some aspects from a scenario that I wasn’t considering, that came with the collaboration*” (P19). In turn, this supported a more open approach to combining factors across categories, in particular with regard to the Individuality & social context category, which served to expand the design space (Bekker & Antle, 2011). During interview, P6 further explained how working in an interdisciplinary group **broadened their own perspective**: “*[P5] saw things a different way. So, it definitely widened my perspective on how people can feel about a technology*”. Other designers underlined the value of involving psychologists in design conversations around user acceptance, in order to discern nuances in users’ behaviours and thought processes, as P20 (clinical psychologist) who discussed the mental health scenario: “*these things [manifestations of depression] can be subtle ... Would a person who, for example, hadn’t worked with vulnerable people ... have picked up on the fact that he [the persona] was perhaps having difficulty with his depression, by turning off his phone, not going to his social events, going to sleep early, feeling more tired?*”.

4.4.3 Supporting Conversations through a Common Vocabulary of Acceptance

Most participants discussed the role the TAC cards themselves played in both facilitating and enriching their communication throughout the workshops. By giving designers the necessary language to discuss acceptance up front — and via a medium that was tangible, accessible, and playful — rewarding discussions about a complex topic were made easier. Multiple participants reported that **the cards were a conversation starter**. As each group comprised participants of varied backgrounds, there was often a wide gap in pre-existing knowledge around acceptance factors. The TAC cards quickly gave participants a shared context through which to engage with one another: *“The cards are like your invitation to join the party”* (P7). The TAC cards lowered the entry point to traditionally complex topics, quickly equipping designers with enough knowledge about a given acceptance factor such that they could meaningfully engage in discussion: *“It’s easier to navigate [than models] ... they serve their purpose so speedily it allowed that conversation to emerge”* (P7). Given the complexity of user acceptance and the often ambiguous terminology found within existing theory, the TAC cards serve, conversationally, as a ground truth from which participants could refine their understanding; P14 explained that they were able to agree on the importance of each factor *“because all of us shared an understanding of the factors”*.

4.5 Findings | Deductive Thematic Analysis along the Temporal Dimension of Acceptance

One of our main objectives with the TAC toolkit was to help designers understand the dynamic and evolving nature of the user acceptance of technology, and how this could be leveraged in design practice. While the inductive thematic analysis (Section 4.4) focused on designers’ experience of using the TAC cards during the workshops, we also wished to further explore an aspect deemed particularly important in the literature: the temporal dimension of user acceptance. Focusing on the temporal dimension of participants’ experiences with the TAC toolkit, the deductive thematic analysis, anchored in the TAL model, investigated how the use of the toolkit supported designers in considering acceptance throughout the user journey, negotiated the interplay between factors, and accounted for the variety of user trajectories as well as the difficulties they faced in envisaging future acceptance issues.

4.5.1 Considering the Question of Acceptance throughout the User Journey

The notion of temporality is key in addressing user acceptance, as the acceptance process is intrinsically linked to the journey of the use of technology over a longer time scale. Designers reported that they could **see the unfolding of a user acceptance journey over time**: “*It kind of felt [like] I’m going on with the user progress ... It made me curious at this step to know what is the next step*” (P19). Considering their richness, it can be taxing to grasp and understand the range of elements influencing user acceptance and how they evolve in time. By creating eight temporal milestones (or windows) inside the user journey, and putting the set of influencing elements in designers’ hands, the TAC toolkit helped participants **understand the reasons behind a user’s trajectory**, and enabled them to **get a richer appreciation of the complexity of user experience**. For instance, P6 described how the temporal dimension of the scenario helped them understand the persona trajectory of abandonment of the technology.

Leveraging the Temporal Continuum: Pre-Use Acceptability — Initial Use Acceptance — Sustained Use Acceptance

Chapter 3 has shown that the *pre-use* stage was often overlooked. In addition, user journeys tend to focus on users’ *interactions* with the technology (e.g. patient journey mapping looking at patients’ ‘touchpoints’ with health technologies (S. McCarthy et al., 2020)), thus failing to consider users’ *perceptions* of the technology. The TAC toolkit aimed to tackle this possible oversight, by showing that the user acceptance journey consists of a **sequence of experiences, each susceptible to changing the user’s perception of the technology**. Participants observed this connection when the persona Ella took on the glucose monitoring app:

Ella (P8): « *Setting it all up was easier than I expected. The sensor is attached to my stomach, just above my hip. It’s a bit weird but it’s discreet. I’ll get used to it ...*

P9: *The ‘technology anxiety’ she [Ella] has has been suddenly reduced.*

P7: *Yeah, there’s a sense of ‘enjoyment’ in terms of [the app] being initially usable, easier than expected. »*

Furthermore, most studies measuring acceptance have focused on the *sustained use* stage (see Chapter 3), evaluating the extent to which users have accepted the technology after long-term use. This approach reduces acceptance to a point measure, which does not capture the evolution of user experience. Measuring *sustained use acceptance* also requires deploying the health technology, potentially with a clinical population. This is a more taxing process for gaining insight into acceptance problems that could have been identified earlier in the course of design. The TAC toolkit, as an exploratory design tool thus used at an early design stage, enabled designers’ to **look into prospective user acceptance issues** with a system, but also to **understand how design choices could lead to a particular user acceptance trajectory**. P20 explained that, in the *sustained use stage*

of the workshop, they noticed “[the persona] is still in the same [problematic] place: what does that mean?”. They then reflected on the acceptance factors the group had flagged as relevant in the previous steps of the user journey: “we had picked that before and now he [the persona] is here. So, you know, what do we need to think of for the technology?”.

4.5.2 Negotiating the Interplay among Factors Influencing Acceptance

The weight of each acceptance factor varies throughout the user acceptance journey, some proving more pertinent at the *pre-use* stage and others having more impact on the stage of *long-term use* of technology. The multi-choice scenario gave designers the opportunity to explore different trajectories for the same persona, depicting various issues of acceptance. Each group’s final think-space provided a **visualisation of the trade-off between acceptance factors** — as reflected in Fig. 4.8 which shows how user’s ‘anxiety’ is first reduced by their ‘enjoyment’, but later exacerbated by the system ‘usability’ and the person’s lack of ‘trust’. This is an important finding which suggests that, not only how factors within the same step influence each other, but possibly also how factors in subsequent steps do so — i.e. inter-temporal dependency.

Complementarity between acceptance factors was also rendered visible, **making explicit the complex nature of some acceptance issues**. The notes taken by Group 6 reflect the interdependency between the cards ‘healthcare professional relationship’, ‘trust’ and ‘self-image’ they selected: “We pick the cards because the app is sharing Ali’s [the persona] little secrets with the doctor and she feels upset, as she thought it was going to be a useful tool”.

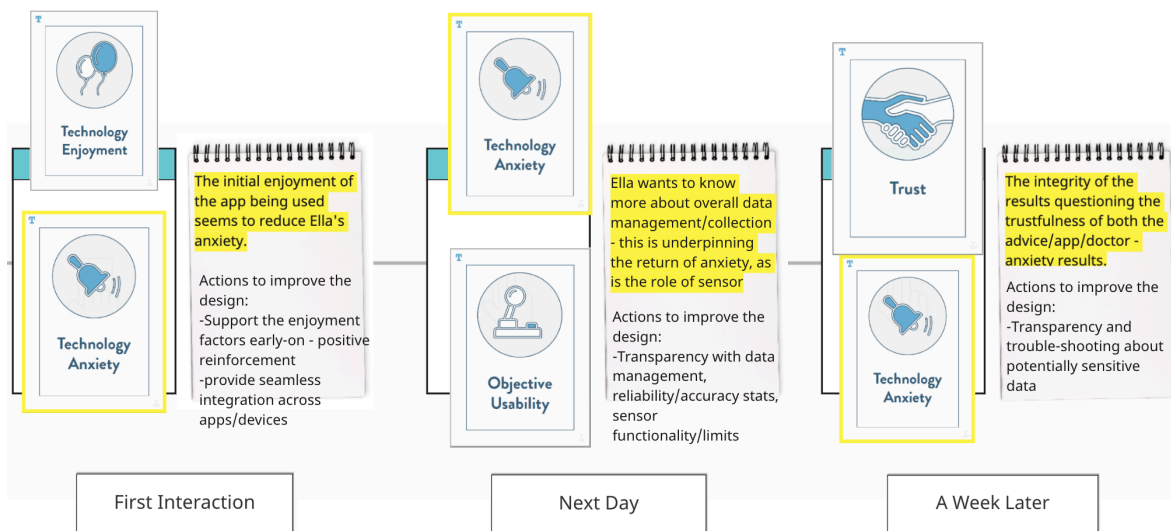


Figure 4.8: The think-space generated by Group 3 showing their notes on the negotiation of 4 antecedents: technology anxiety, enjoyment, system usability, & trust, across the 3 temporal milestones of the *initial use* acceptance stage. Elements of interest are highlighted.

Finally, creating new meaning through the think-space’s virtual elements, some participants represented the interplay between factors by overlaying cards on the board:

P1: « *It's like both [factors] overlayed on top of each other ... it's maybe more 'health beliefs and concerns' because... Oh I don't know, it's kind of both...*

P2: *We can maybe put one [card] on top of another, like showing that they overlap? »*

4.5.3 Accounting For the Variety of User Trajectories when Considering Acceptance

The user journey with technology is rarely linear — intermittent or discontinued use proving common issues, particularly in the healthcare context (see Chapter 2). It is essential, therefore, that design accounts for the variety of experiences across the full user journey. However, User Experience models tend to provide punctual representations (or slices) of the user journey (Velt et al., 2017), or tend to adopt an optimistic view on the user's experience, failing to capture how a technology can be abandoned at any stage in the user journey — even before the first use (Karahanoğlu & Bakırlioğlu, 2020). Being able to explore the user journey through temporal windows, but also **from both more and less optimistic perspectives**, helped designers envisage various possible user trajectories. P17 (who played the persona) reflected on the activity of selecting a storyline among the three available at each scenario step: *"I found it quite useful to have these scenarios, to see how things could go"*.

4.5.4 The Difficulty of Envisaging Future Acceptance Issues

Velt et al.'s review found that *"taking into account, trajectories helped with the design of future experiences"* as *"trajectories raised novel design requirements for a class of experiences"* (Velt et al., 2017, p. 2095). During the workshop, participants worked with prospective user trajectories, in a near or distant future, which enabled them to **design for possible future issues regarding acceptance**. Although most designers are familiar with reflecting on users' *past* experiences, envisaging *future* experiences — especially distant ones — was for many both novel and challenging. Two aspects of the design task threw off some participants.

First, the length of the time scale negatively impacted designers' ability to envision users' trajectories, particularly those distant in time: *"It's very hard for me to take that whole year-long view ... the ask was getting too fine-grained on something [a user trajectory] that's more sketchy"* (P18). To address the difficulty of working with a detailed view of the long-term user journey, P18 suggested an iterative approach where designers would first *"try and get the basics down and move on to the next one [temporal milestone]"* before *"zoning in on each one [milestone] to go more in depth"*.

Second, some participants commented on **an impression of a too rapid passing of time**, which was materialised by the time intervals between each scenario step: *"Even though you actually had '1 week', '3 months', '1 year' ... it was a bit fast in some sense"* (P11). The granularity of the time intervals was mentioned as a possible reason for this impression: *"the temporal side wasn't quite the right granularity"* (P5). Thinking back on the group's design ideas to address future acceptance issues, P11 commented seeing more substance

in that last part of the journey: “*There was a lot more to discuss somehow in that because now the user has been using it [the system] ... it will be interesting to have even more snippets of stories in that area*”.

This last section highlights the importance of finding the right balance between offering sufficient details concerning users’ future acceptance trajectories, and realistically representing the timeline of use of many health technologies.

4.6 Discussion

Our exploration of the use of the TAC toolkit indicates designers’ overall enjoyable experience of engaging with the materials and activity, as well as the method’s playfulness as facilitated in particular by the cards. We now reflect on the value of the TAC toolkit, for supporting reflection on and design for acceptance from a macro-temporal perspective, and discuss the impact of the use of such toolkits on designers’ knowledge, values, and behaviours, with a focus on intentions to change future design practice.

4.6.1 Revising & Extending Knowledge of Technology Acceptance Process: Dynamic, Multi-stage, Complex

Findings indicate that the proposed TAC toolkit prompted designers to change the way they think about acceptance. The toolkit and associated method supported participants in gaining richer design knowledge of acceptance in three main directions.

Firstly, it helped them uncover and challenge inaccurate assumptions that acceptance is a static process with limited temporal qualities rather than a dynamic one to be best understood from a macro-temporal perspective. Thus, our findings extend those on user experience frameworks focusing on discrete experiences (Forlizzi & Battarbee, 2004; J. McCarthy & Wright, 2004) and those that change in time (Karapanos et al., 2009a), by integrating a theoretically informed macro-level temporal perspective of technology acceptance (K. Doherty & Doherty, 2018a). We have introduced a novel type of scenario — which we call *temporal multi-choice scenarios* — that we designed to embody such a macro-temporal perspective through the eight temporal milestones within the three stages of the TAL model. Unlike the traditional scenario depicting situated use of technology at a single and usually indeterminate moment in time, our approach marked a significant shift accounting for the temporal dynamic of user acceptance process, thus going beyond individual experiences to experiences changing in time. We define *temporal multi-choice scenarios* as a sequence of scenarios capturing the evolution of users’ interaction at a macro-temporal level, from *acceptability* and *initial acceptance* to *sustained acceptance*, while also providing the choice of exploring low, medium or high degrees of challenge in relation to different acceptance factors relevant at each temporal milestone. To visually represent these scenarios, we employed the concept of interactional trajectories (Benford et al., 2009) via the TAC website (Fig. 4.5), which we further tailor as *interactional acceptance trajectories*. We define these as visual

representations of richer trajectories extending over space and time, especially across the eight temporal milestones of the TAC toolkit, involving specific user groups engaging with a target technology.

Secondly, findings showed how such toolkits and methods could challenge the assumption that acceptance is a simple one-stage process, no longer relevant once the technology starts being used. In other words, it helped revise designers' mental model of acceptance as a multi-stage process, as argued by a wealth of theoretical models (Sekhon et al., 2017; N. Martin et al., 2015; Distler et al., 2018; Terrade et al., 2009; Garces et al., 2016; Somat et al., 2012; Rogers, 1983), whose relevance for design practice has been less explored. In particular, findings indicated participants' richer understanding of the importance of considering in design the other stages of the acceptance process, stretching both before and after the *initial use* stage within the TAL model.

Thirdly, the method explored (incorporating the TAC toolkit) provided an engaging and accessible operationalisation of the rather complex acceptance process, and its rich set of antecedent factors from self-image (Venkatesh & Davis, 2000), computer anxiety (Venkatesh, 2000) or demographics traits (Venkatesh et al., 2003), to health beliefs and concerns (Kim & Park, 2012), and trust (Dhagarra et al., 2020). This is a key outcome towards bridging the theory of acceptance and design practice, given that most of the work on acceptance models has overlooked many of the validated acceptance factors (see Chapter 3). The cards ensured more than mere communication of information regarding these factors, but also deep engagement and constructivist learning of factors' meanings, and more importantly their complementary or trade-off aspects when applied to the situated richness of the selected persona and scenario.

4.6.2 Sensitising towards Designing for Acceptance: Appreciation, Empathy & Ethics

The study has also shown how such toolkits and methods could impact on designers' values, sensitising them towards the appreciation of the dynamic, multi-stage and complex acceptance process, eliciting empathy for the long-term users of health technologies, and helping them unpack additional ethical issues when designing for acceptance. Our rich qualitative findings revealed that designers' appreciation of the acceptance process was underpinned by cognitive emotions of curiosity, surprise, insight, and realisation (Scheffler, 1981). Apart from the cards and their sensitising questions, the method requiring the review and selection of one card per step or temporal milestone of the scenario was key to developing such appreciation.

Empathy was supported by the first-person narrative form of the scenarios, and in particular by our choice of role-play — one of the designers in the group playing out the specific persona and scenario, and standing in for those imaginary users and their acceptance challenges throughout the entire workshop. This participant was furthermore empowered by means of the agency to select one of the three choices or paths of acceptance severity. Participants also unpacked important ethical concerns, and were prompted to reflect on the design actions which might address the identified difficulties in acceptance of these technologies. Their rich answers reflected ethical principles of *transparency*, *autonomy*, *accessibility* or *privacy*, shown in prior research as key

for health and wellbeing technologies (Bowie-DaBreio et al., 2020; Sanches et al., 2019b). While traditional exploratory design methods in general and those for sensitive contexts like health (Hensely-Schinking et al., 2015; Wärnestål et al., 2017; Van Velsen et al., 2012; Vosbergen et al., 2015; Sas, Hartley, & Umair, 2020), have long acknowledged the significance of fostering empathy and ethical values, they have focused mostly on *discrete* user experiences rather than *continuous* experiences as entailed in long-term acceptance and its macro-temporal perspective.

4.6.3 Impacting Future Design Practice

In addition to helping designers change how they think and feel about designing for long-term acceptance of health technologies, our findings also suggest the value of such toolkits as means of shaping participants' future design practice. Participants' expressed desire to use the TAC toolkit in their future practice is a significant outcome, given that intended behaviour change is an indicator of transformative learning as highlighted in several models of reflection (Mezirow, 1990). Interestingly, the perceived ease of use of the TAC toolkit made it an attractive design tool envisaged to be used also with other stakeholders, and importantly, with future users in early stages of the design process. Traditional exploratory design methods intended to bridge the design gap (Sas et al., 2014) such as personas (Marsden & Haag, 2016), scenarios (Young & Barnard, 1986), design cards (Bornoe et al., 2016), or toolkits (Ledo et al., 2018) have focused predominantly on the design of technologies for the *initial use* stage, with limited focus on the *pre-use*, and *sustained use* stages. The explored method, however, increased participants' awareness of change at two levels: change in users' needs over time, and change to their constellation of relevant determinants of technology acceptance. Together, these changes demand a broader and more flexible set of requirements for technology design.

4.6.4 Implications for Design Research

We now reflect on the implications for design research entailed in our findings. We discuss the value of integrating design tools to better support the bridging of acceptance theory and design practice, of considering the evolution of acceptance factors, and how such toolkits may also evolve over time and for more tailored support for designers to imagine future experiences in the *sustained use* stage.

Integrating Design Tools for Bridging Acceptance Theory and Design Practice

The study indicates the value of the proposed TAC toolkit for articulating and leveraging theoretical HCI work on technology acceptance, in order to better inform the design for acceptance of health technologies. The significant need within HCI for bridging the gap between theory and design practice has been long acknowledged, and efforts to address it have led to conceptual contributions, such as translational resources (Colusso, Bennett, Hsieh, & Munson, 2017; Colusso, Jones, Munson, & Hsieh, 2019), intermediate design knowledge, strong concepts (Höök & Löwgren, 2012), bridging concepts (Dalsgaard & Dindler, 2014), bound-

ary objects, (Velt et al., 2020) or implications for design (Sas et al., 2014). However, despite the progress made at a conceptual level and the wealth of traditional design tools, those for better bridging the gap are still much needed. We argue that the value of such toolkits — and in our case the TAC toolkit — resides in the integration of exploratory design methods, such as personas and scenarios, with the TAC cards, and within the think-space and website. While personas and scenarios have been traditionally coupled in design research (Dix et al., 2003; Cooper et al., 2012), our findings suggest the added value of integrating these with acceptance theory, operationalised through the TAC cards and their sensitising questions.

Considering the Evolution of Acceptance Factors in Designing Tools for Acceptance

Another implication for design tools supporting long-term acceptance of health and mental health care technologies is accounting for how the antecedent factors of acceptance may change with time and the emergence of technological innovations and new contexts of use. This has been reflected in the evolution of models of acceptance, moving from a focus on technologies for the workplace (F. Davis, 1986; F. D. Davis et al., 1989; Taylor & Todd, 1995; Venkatesh & Davis, 2000; Venkatesh, 2000; Venkatesh & Bala, 2008; Venkatesh et al., 2003), through pervasive technologies (Venkatesh et al., 2012; Connelly, 2007), to healthcare technologies (Kim & Park, 2012; C.-L. Hsu et al., 2013; Dou et al., 2017; Schomakers et al., 2019; Dhagarra et al., 2020). Our findings also provide empirical support for *ethicality* as an emerging antecedent of technology acceptance (Paska, 2021; Perski & Short, 2021a; Tabourdeau & Grange, 2020). This is a clear indication that, while the TAC cards comprise an effective capturing of today's most relevant antecedents factors, they will benefit from future revisions in order to align with evolving technologies and their users' needs.

Supporting Design for Long-Term Acceptance

Unlike the exploration of user acceptance challenges before and at the early stages of use of the technology, considering distant user acceptance issues (in the *sustained use* stage) was challenging. This is related to the less familiar task of envisioning the long-term evolution of user experiences, and how to infuse situated details with regard to distant future experiences. Despite these challenges, designers appreciated the importance of such future experiences, and highlighted the value of a longer design activity to address those.

For this task, designers may benefit from tailored support for future design (Kozubaev et al., 2020) and its specific thinking skills. To this end, we can draw from findings on cognition research, showing that future events can be better imagined and pre-experienced when they are positive, and rich in sensorial details (D'Argembeau & Van der Linden, 2004). We can imagine temporal multi-choice scenarios that are richer in sensorial details to support designers in this task. These may also integrate more affective and bodily aspects, inspired for instance by visual poems communicating the experience of living with HIV (Claisse, Kasadha, & Durrant, 2020), or vignettes and postural images communicating the lived experiences of depression (Sas, Hartley, & Umair, 2020). This in turn can support designers' stronger cognitive and emotional engagement while designing for *sustained use acceptance*.

4.6.5 Re-Using the TAC Toolkit in Design Practice

HCI researchers and designers, interested in health technologies and designing for their acceptance, can use the entire TAC toolkit — as we have done in our workshops. Given that our findings have already indicated the usefulness of the cards across three distinct persona-scenario pairs, we also envisage the use of the TAC cards to support designing for acceptance of health technologies for other health and mental health difficulties. For this purpose, interested designers can use the TAC cards alongside their own bespoke personas and temporal scenarios. The granularity of the temporal milestones can also be extended as required, since our findings indicate designers' interest in intermediary milestones in the *sustained use* stage. To use the TAC toolkit with personas and temporal scenarios, we recommend that designers follow these steps: (i) get familiar with the persona, (ii) consider the scenario snippet for the first temporal milestone, (iii) use the TAC cards to determine which acceptance factors are at play in the snippet, (iv) if working in group, reach consensus on the main factors (1 to 3) at play, (v) brainstorm and put together actions to improve the technology design.

4.7 Conclusion

This chapter explored a way to support designers in addressing user acceptance of health and wellbeing technologies at design stage. This approach took the form of the TAC toolkit, a novel, theory-based design tool and method, embedding a large set of validated factors of acceptance, and the temporal dimension of the process. Results of a practical evaluation of the toolkit with 21 designers showed that such approaches could revise and extend designers' knowledge of technology acceptance, foster their appreciation, empathy and ethical values while designing for acceptance, and motivate its future use in their design practice. We discussed implications for considering user acceptance as a dynamic, multi-stage process in design practice, better supporting designers in imagining distant user acceptance challenges, and examined the generative value of such design toolkits and their possible evolution over time.

This chapter revealed the value of the TAC toolkit, which by conveying validated acceptance factors and the longitudinal aspect of the process in an accessible manner, can efficiently support design for acceptance. However, we can imagine other approaches, relying on different supports to transmit the theoretical knowledge on technology acceptance. Key elements for designing tools and methods to support designers addressing user acceptance are discussed in Chapter 7.

Having explored how to facilitate design for user acceptance, we next look into how to support the longitudinal evaluation of user acceptance of health and mental health care technologies.

Chapter 5

Measuring Acceptance Longitudinally in Clinical Settings

With Chapters 2 & 3, we have examined how user acceptance was defined, discussed and measured in theory and in practice. This work also revealed the challenges designers face in addressing technology acceptance in design, resulting in a lack of consideration of the question at design stage. With Chapter 4, we have explored a method to facilitate designing for acceptance, and examined its application in practice. The next thing we come to consider is how we might investigate user acceptance of health and mental health technologies, later in the technology lifecycle, at an empirical level. The present chapter explores a novel, theory-based, longitudinal approach to measure user acceptance, relying on the Technology Acceptance Lifecycle timeline (*pre-use, initial use, sustained use*). This chapter looks at the particular case of mental health care technologies, a context under-explored in the literature, albeit particularly challenging in terms of technology acceptance. We first present the Mood Monitor smartwatch app, a practical example for the study of user acceptance in a mental health care context. We then describe the protocol for the study of acceptance of the Mood Monitor app, in the context of an 8-week randomised controlled clinical trial with patients undergoing a routine treatment for depression. Finally, we detail the longitudinal approach to measure acceptance in that context, aiming to (i) evaluate the level of patient acceptance of the Mood Monitor app and its evolution over time, (ii) identify the facilitators and barriers to patient acceptance, and (iii) explore the potential between-group differences introduced by the addition of the smartwatch, in terms of acceptance of self-report, actual use of self-report, use of the iCBT intervention, and clinical outcomes. This chapter finally discusses the issues associated with the implementation of this method in a clinical mental health care context. This chapter is therefore a first contribution to answering the third Research Question¹. This work is a collaboration with a clinical team. I conceptualise the study, designed and developed the smartwatch app, designed the study protocol and applied for ethics approval, and managed the project. Caroline Earley (clinical psychologist) acted as liaison with the clinical team, and helped with project administration. Dr

¹RQ3: How can we evaluate user acceptance longitudinally, in a mental health care context, and draw on the results to inform the technology design? What are the challenges of conducting user acceptance research in clinical settings?

Angel Enrique provided feedback on the methodology.

5.1 A Practical Study Example: a Smartwatch App for Mood Self-Monitoring

This section presents the Mood Monitor smartwatch app, a practical example for the study of user acceptance in a mental health care context. We first explain the rationale for this case study. We then review practices for mood monitoring in mental health interventions in terms of delivery methods, including the traditional pen-and-paper approach, mobile self-monitoring, and self-monitoring on smartwatch. Finally, we describe the design of the Mood Monitor watch app, and its integration in an existing treatment for depression.

5.1.1 Assessing Acceptance of a Novel Use of Smartwatches

For the purpose of exploring the longitudinal measure of user acceptance, we consider the interesting case of mood and lifestyle habits self-monitoring on smartwatch, in the context of a routine internet-delivered Cognitive Behavioural Therapy (iCBT) for depression. This decision was motivated by several reasons.

While smartwatches have the potential to enhance self-report delivery (see next section), the novelty of using this technology in a routine treatment for depression accentuates the need to investigate its acceptance. Indeed, if owning a smartwatch has become common in the general population — for instance for the tracking of lifestyle habits — using this technology to support an iCBT intervention has not yet been explored. Therefore, the use of a smartwatch in such clinical context needs to be investigated beyond effectiveness, in order to understand possible acceptance issues it might bring. For instance, the automatic collection and use of patients' physiological data — to identify sleep pattern and activity level — might impede patients' sense of privacy protection, or modify the relationship with their therapist.

Finally, the wearable nature of the smartwatch implies a different way to interact with technology, during the self-report activity but also in daily life. Indeed, if one can easily disconnect from their computer or mobile phone by distancing themselves or turning the device off, a wearable device makes it more difficult to disengage from technology. Yet, it is specifically its wearable nature that makes the smartwatch a good candidate for supporting consistent self-report. Thus, it is essential to assess patient acceptance of using this device, for the purposes of therapy.

The case of self-monitoring on smartwatch is therefore a promising technological innovation for mental health care, but also one that might raise acceptance issues in patients. There is much value in understanding what these issues might be, but also identifying what might facilitate patient acceptance of this tool in a clinical intervention.

5.1.2 Practices for Mood Monitoring in Mental Health Interventions

Self-report is often encouraged by mental health professionals. Individuals undergoing therapy may be asked to keep track of their mood and other aspects of their life, such as sleep and physical activity. Sharing this information during therapy sessions enables patients to reflect on past experiences and feelings, and informs therapists on behavioural patterns and eventual trigger-elements for their patients (Stone, Bachrach, Jobe, Kurtzman, & Cain, 1999). With a deeper insight into patients' experience, therapists are better equipped to set up adapted interventions (e.g. behavioural change interventions) and provide personalised follow-up.

Traditional Self-Monitoring

Keeping a log on a paper diary is the traditional way patients self-report moods, however this approach presents several issues. First, studies have shown that patients were likely to forget to report in the moment, and tended to complete their logs retrospectively (Spector et al., 1986; Shiffman, 2000). In addition, retrospective logging is dependent on one's ability to accurately reflect on past moods, and is subject to recall biases (K. Doherty & Doherty, 2018a; Solhan, Trull, Jahng, & Wood, 2009). These include mood-related bias (Bower, 1981), events salience (Strongman & Russell, 1986; Stone et al., 1999), and depressive symptoms (Bower, 1981; Kahneman, Diener, & Schwarz, 1999; Smith & Petty, 1995). Second, the task of self-report itself was also experienced as repetitive and binding because of the necessity to carry a journal throughout the day (Toledo, Hekler, Hollingshead, Epstein, & Buman, 2017).

Mobile Self-Monitoring

With the advent of smartphones, mood monitoring has become a frequent activity for a number of people (Davies, 2017). Ecological Momentary Assessment (EMA) (Stone & Shiffman, 1994) on smartphone enables individuals to log their mood in-the-moment, avoiding retrospective reflection and therefore minimising recall biases. EMA also permits the collection of contextual information (e.g. time of the day, activity level, etc.) to situate the mood in one's daily experiences (Wichers et al., 2011). For these reasons, EMA is becoming increasingly used for mood monitoring in individuals with mental health difficulties (Trull & Ebner-Priemer, 2009; Colombo et al., 2020). Research also started to move away from a fully manual EMA matthews2016development towards automated monitoring via sensors embedded in smart technologies, for example in the MONARCA project (Faurholt-Jepsen et al., 2013). This was particularly motivated by the potential for automatic data collection to improve self-report accuracy, lessen the risk of missing records, and reduce the burden associated with manual data entry (Nicholas, Larsen, Proudfoot, & Christensen, 2015; Belisario et al., 2015; Dogan, Sander, Wagner, Hegerl, & Kohls, 2017). Finally, research has looked at the case of semi-automated monitoring — the combination of manual self-report with automatic data collection — to support patient awareness, long-term engagement, and sense of agency (Choe et al., 2017; Zhang, E. Ringland, Paan, C. Mohr, & Reddy, 2021).

Self-Monitoring on Smartwatch

Wearable devices are becoming increasingly used by the general population, in particular smartwatches for the monitoring of health-related behaviours such as sleep and physical activity (Piwek, Ellis, Andrews, & Joinson, 2016). Smartwatches have advantages over smartphones in this regard, affording the possibility of continuous monitoring of a wider range of physiological variables, the ability to provide biofeedback (Umair, Sas, Chalabianloo, & Ersoy, 2021), and a greater convenience (Ometov et al., 2021). As a result, commercially available smartwatches have begun to be used in healthcare research (Umair, Chalabianloo, Sas, & Ersoy, 2021). The potential of wearables also extends to the mental health domain. Studies have explored the use of automated self-report on wrist-worn devices for mental health diagnosis (detection of depression through sleep and heart rate monitoring (Vincent et al., 2021)), treatment (understanding outcomes of social anxiety treatment through heart rate and movements (Boukhechba et al., 2018)), and symptom monitoring (physical activity monitoring to detect depressive symptoms (J. O'Brien et al., 2017; Burton et al., 2013)). In addition, because mental health stigma has been a long standing barrier to help-seeking and treatment compliance (Bharadwaj, Pai, & Suziedelyte, 2017; Ahmedani, 2011), it is essential that self-report technologies maintain a high level of privacy. Due to their proximity enabling immediate, discreet, and private interaction, smartwatches are good candidates for supporting the self-report of sensitive data, such as one's moods (Motti, 2018; Cormack et al., 2019).

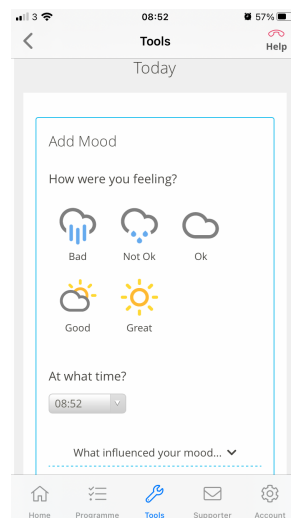
To conclude, while smartwatches are well integrated in the general population, their use in clinical contexts is still at a very early stage. As we have seen in Chapter 2, evidence showed that patients' willingness to engage with digital self-report on smartwatch will significantly be determined by their acceptance of the device. In addition, there has been a call for HCI researchers to conduct clinical evaluation of new mental health technologies (Sanches et al., 2019b). Therefore, as also recommended by the literature, it is important to consider patient acceptance as an essential design factor (Sekhon et al., 2017; Dillon & Morris, 1996), but also to evaluate these technologies in clinical settings.

5.1.3 Integrating Mood Monitoring on Smartwatch in an Existing Treatment for Depression

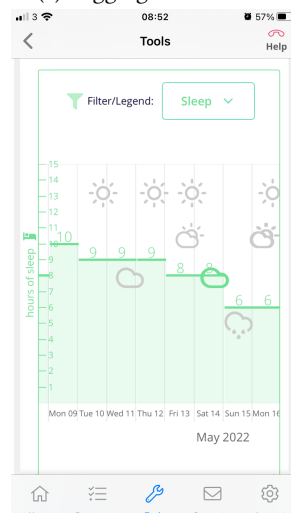
Responding to the exposed areas for improvement for the self-monitoring of the mood, we developed the Mood Monitor watch app with the intention to (i) enhance the accuracy and completeness of mood self-report, (ii) stimulate reflection on the influence of lifestyle choices on mood, (iii) minimise the patient burden, and (iv) offer an acceptable means to self-monitor mood, within the iCBT intervention 'Space from Depression'. Our work on the TAC Toolkit taking place in parallel to this study, the toolkit was not used to design the Mood Monitor app. However, we draw on the TAC Toolkit in our discussion of the evaluation study results (see Chapter 6 Section 6.7.3).

The ‘Space from Depression’ Programme and Mobile Mood Monitoring

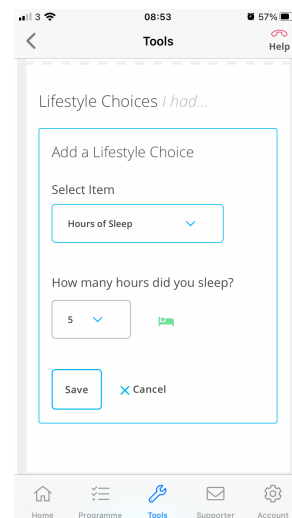
The ‘*Space from Depression*’ programme provided by SilverCloud Health (S.H. Inc, 2021) is a widely used, validated iCBT intervention for the treatment of depression, whose effectiveness has been shown in several randomised controlled trials (Richards et al., 2020, 2015). The intervention is accessible through a website (desktop) and mobile app, with treatment completion estimated to be reached around 8 weeks. The programme consists of seven modules, each taking approximately 1h to complete; clients are generally recommended to complete one module per week. If lapses in engagement are noticed, the therapist calls the patient to troubleshoot any problems, re-evaluate homework, ensure understanding and promote engagement. The structure and content of the programme modules follow evidence-based CBT principles and is delivered in a client-directed fashion. Each module incorporates introductory quizzes, videos, psycho-educational content and interactive tools, as well as personalised homework suggestions and summaries.



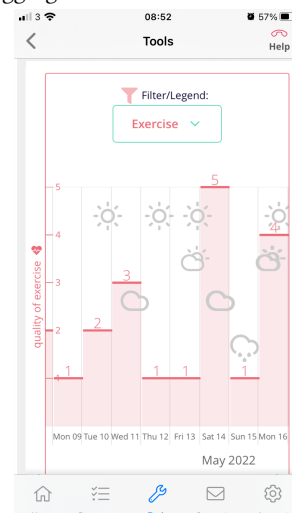
(a) Logging of the mood



(c) Visualisation of sleep data alongside moods



(b) Logging of the number of hours of sleep



(d) Visualisation of exercise data alongside moods

Figure 5.1: Mood Monitor on the mobile app, S.H. Inc (2021).

The Mood Monitor is one of the interactive tools offered by the ‘*Space from Depression*’ programme. Helping patients identify key areas for change, this tool is a core element of the treatment (Richards et al.,

2016). The Mood Monitor is introduced in the first module of the intervention, and allows patients to log their mood by selecting from five weather icons (sun, sun-cloud, cloud, cloud-rain, rain) the one that best reflects their current mood (see Fig. 5.1a). They are then encouraged to reflect on a list of lifestyle choices, and log the number of hours slept, quality of exercise, diet, caffeine drinks, units of alcohol and level of medication (see Fig. 5.1b). The Lifestyle Choices chart provides a visualisation of the mood alongside these factors (see Fig. 5.1c & 5.1d), therefore encouraging them to reflect on the evolution of their mood and the influence of their lifestyle. Users can also schedule daily reminders to log their mood. Although previous studies reported the positive feedback patients gave about the Mood Monitor tool (Richards et al., 2016; Palacios et al., 2018), engagement with the self-report of lifestyle habits was low (Richards, Dowling, O'Brien, Viganò, & Timulak, 2018).

This lays the ground for the Mood Monitor application for smartwatch, which was collaboratively designed and implemented over 18 months by an interdisciplinary team of HCI researchers, clinical psychologists, and professional UX designers with extensive expertise in digital mental health. The smartwatch app offers a manual self-report of the mood, and automated monitoring of sleep and physical activity, and is open-source (Nadal & Doherty, 2021).

Designing more Accurate and Complete Self-report

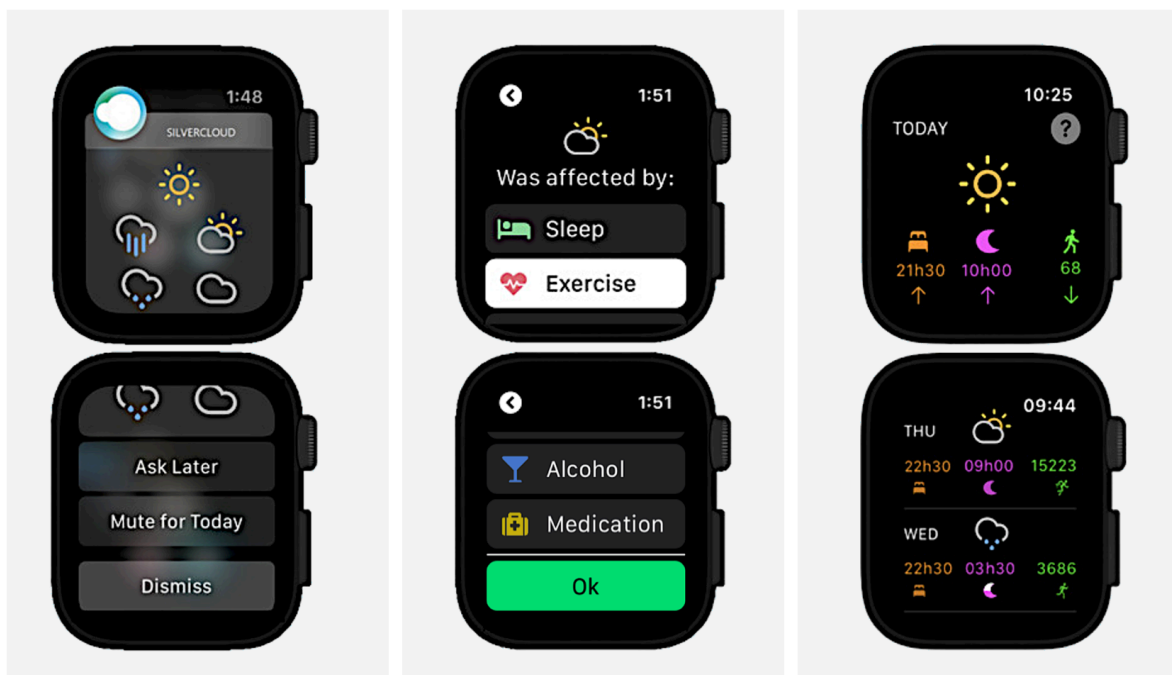


Figure 5.2: The Mood Monitor watch app 1) prompts the patient to log their mood several times a day, 2) lets them select influencing factors, and 3) displays a daily and weekly summary of their mood alongside bedtime (bed icon), hours slept (moon icon) and step count (jogger icon).

The core functionality of the Mood Monitor watch app is the self-report of the mood. Taking advantage of the ubiquity of the watch, this was designed in the form of an Ecological Momentary Assessment, for the collection of mood data in daily life. The EMA was implemented by prompts on the watch screen, reminding

the user to log their current mood at random times of the day (Fig. 5.2.1), in order to account for the variance of mood across the day (Wichers et al., 2011). Because patients are more likely to engage when prompted (Bidargaddi et al., 2018), the daily reminders also act as a means to prevent gaps in self-report, capturing “the film rather than a snapshot of daily life” of the patient (Wichers et al., 2011, p. 266). After logging their mood, patients are presented with an evidence-based list of lifestyle elements likely to influence their mood, and asked which one(s) they think might have affected it (Fig. 5.2.2). Reflecting on these lifestyle factors is key in the identification of patterns in one’s behaviours and mood. The Mood Monitor app also contains a menu² enabling the independent logging of moods (Fig 5.3.1).

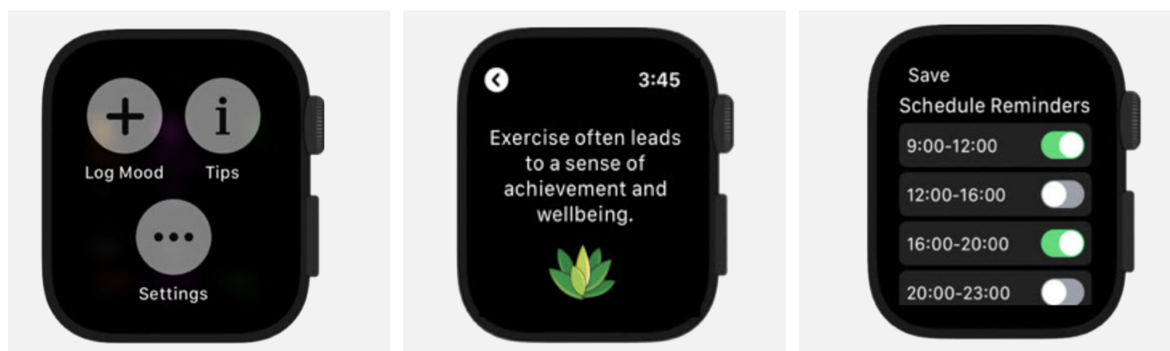


Figure 5.3: 1) app menu, 2) tips to stay well, 3) settings.

In addition to the mood logging, the Mood Monitor smartwatch app integrates the monitoring of daily data related to sleep (bedtime and number of hours slept) and physical activity (step count), giving context to the patient’s moods. Previously requiring manual logging, the self-monitoring of these lifestyle factors is automated on the watch, therefore enabling a passive self-report, less subject to bias, human error, and inconsistencies.

To allow retrospective reflection, mood and lifestyle information recorded on the watch app is automatically integrated into the Mood Monitor tool on desktop and mobile app, accessible through the patient’s account on the SilverCloud Health platform³.

Encouraging Introspection and the Identification of Mood Patterns

The Mood Monitor smartwatch app is also designed with the aim to encourage patients’ reflection and support them in identifying patterns. While awareness might be gained from simply recording one’s mood and lifestyle habits, encouraging deeper reflection is essential to support behaviour changes. We designed the Mood Monitor app so that, after logging their mood, the user is directly brought to the application’s home screen, and is immediately presented with a visualisation of their mood, bedtime, hours of sleep, and step count throughout the past week (Fig. 5.2.3). Providing a detailed view of how the patient has been doing, this visualisation acts as a prompt to reflection. In addition, the mood, sleep and physical activity data recorded through the watch app is synced with the patient’s SilverCloud account, and shared by default with their

² Accessible with a ‘Force Touch’.

³ Patients can still use the Mood Monitor tool on desktop and mobile app to self-report their mood and lifestyle choices

supporter⁴. To encourage frequent and consistent logging of mood, encouraging prompts (validated by a clinical psychologist) were provided when users reached goals regarding compliance with the mood logging, and maintaining of a sleep routine (see in Figure 5.4).

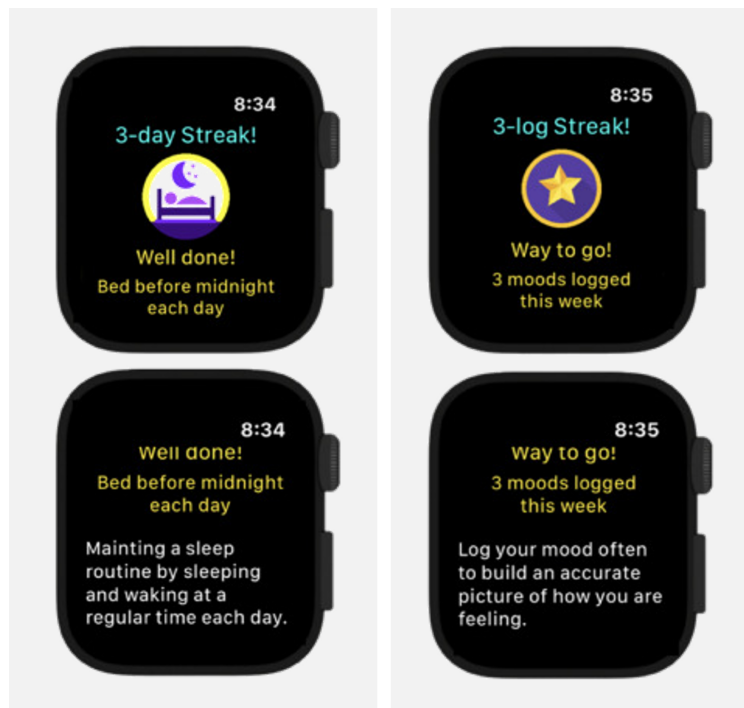


Figure 5.4: Encouragement prompted to the user after logging 3 moods in the Mood Monitor watch app.

Finally, we chose to explore the addition of psycho-education bites on the smartwatch, in the form of ‘Tips to Stay Well’, accessible from the menu of the app (Fig. 5.3.2). Patients can go through this list of 31 brief educational pieces on lifestyle choices that may influence depression symptoms extracted from the programme and approved by a clinical psychologist.

Minimising Patient Burden and Perceived Stigma

Mood logging on the smartwatch was intended to be as effortless as possible for patients. While 5 taps were required to log a mood on the desktop and mobile app, only 1 is needed on the watch, as pop-up reminders enable immediate mood recording. Due to the proximity of the watch, time is also saved in terms of the user not having to reach for their phone and logging into the programme, with the associated possibility of distraction. In addition, the passive monitoring of sleep and physical activity means that the patient is not required to type in this information at the start and end of each day, thus eliminating a repetitive task that risked impeding patient engagement. The proximity of the watch, along with its small screen and discreet interactions (quick vibration on the wrist), enable the Mood Monitor watch app to deliver self-report more subtly and privately than via a smartphone or computer (Motti, 2019). Since previous findings have shown the value of personalisation in mobile health interventions (Anastasiadou, Folkvord, Serrano-Troncoso, & Lupiañez-Villanueva, 2018; Juarascio et al., 2015; Umair et al., 2020), it was important to enable patients to

⁴This sharing can be disabled in the account Settings.

change the frequency and timing of the mood reminders. We chose to let users increase/reduce reminder frequency (from the default twice a day recommended by a clinical psychologist) by switching On/Off time ranges, at the first launch of the app (see Fig. 5.3.3).

Table 5.1 summarises the potential improvements brought by the Mood Monitor smartwatch app to the original self-report delivery on the desktop and mobile app.

Table 5.1: Summary of the changes brought by the Mood Monitor smartwatch app.

Features	Desktop & Mobile app	Smartwatch app
Mood monitoring	– Manual, 5 taps – Current and past moods (subject to bias) – Scheduling reminders is up to the patient	– Manual, 1 tap – In-the-moment mood (better accuracy) – Reminders automatically scheduled – Patient can adjust reminders timing
Sleep & activity level monitoring	– Manual	– Automated
Progress visualisation	– Requires 2 taps plus 1 scroll – Weekly	– Readily available (main screen) – Daily and weekly – Patient receives encouraging prompts
Tips to Stay Well	– Accessible in the different modules of the programme	– Gathered in a feature accessible in 2 taps

5.2 Protocol for the Case Study on Acceptance in a Mental Health Care Context

We present here the protocol for the case study of acceptance of the Mood Monitor smartwatch app (presented earlier), in the context of a routine treatment for depression. The study comprises two arms: the routine intervention alone (control group) and the routine intervention with smartwatch (intervention group). This section describes the study context, logistics, and procedure; the longitudinal approach to measure acceptance is outlined in the next section.

5.2.1 Study Setting

This case study was conducted within Berkshire Healthcare NHS Foundation Trust in the UK, and the ‘Improving Access to Psychological Therapies’ (IAPT) programme. IAPT is a stepped care model for the treatment of depression and anxiety. Specifically, the study was placed at step-2 of their IAPT service, offering internet-delivered CBT programmes to patients assessed eligible at their initial assessment with a clinician. Step 2 services are generally offered to individuals with mild to moderate presentations of depression and anxiety, and they include low-intensity CBT-based treatments supported by trained therapists. Those wishing to access the service can do so through self-referral, GP referral or referral from allied services. The study was approved by Research Ethics Committee (Wales REC 5 281255). It was registered at ClinicalTrials.gov (NCT04568317), and was conducted in compliance with the General Data Protection Regulation (EU) 2016/679

(GDPR), and the Data Protection Act 2018 (Section 36(2)) (Health Research) Regulations.

5.2.2 Assessing Acceptance in a Multi-Arm Context

Multi-arm studies, and particularly randomised controlled trials, are a common setup (i) to assess the feasibility of health and mental health technologies, and (ii) in HCI research. This study further serves as an opportunity to explore how we can use multi-arm trials as opportunities to evaluate user acceptance. Indeed, we adopted a randomised controlled setup with two arms: the routine intervention alone (control group) and the routine intervention with the smartwatch (intervention group). Moreover, having a control group provides a useful reference point: if patient acceptance of the smartwatch app is significantly higher (or lower) than that of the control intervention, then exploring patient acceptance in both groups might give us insight into what caused it.

Sample Size

We have seen in Chapter 2 that acceptance studies' sample size could range from under 70 participants, to larger samples, and up to over 1,500 people. We decided to follow recommendations around desired sample sizes for feasibility studies. These included Teare et al. recommendation for 35 subjects per group (Teare et al., 2014), and a review by Billingham et al. (Billingham, Whitehead, & Julious, 2013) which found that the median pilot study sample size was 30 per arm for continuous endpoints. We therefore decided to aim to recruit a sample of 70 participants, with 35 participants per group.

5.2.3 Eligibility Criteria

Users of the step 2 service who were assigned to the iCBT treatment for depression and own a compatible smartphone (iPhone 6 and upwards running iOS 8) were eligible to participate. Suitability for an internet intervention was assessed by the therapists on site following the criteria described in Table 5.2. Individuals who did not meet the inclusion criteria, or did not wish to participate in the study were offered appropriate treatment.

Table 5.2: Study eligibility criteria.

Inclusion criteria	Exclusion criteria
• Minimum age of 18 years • Eligible for the '<i>Space from Depression</i>' programme • Own a compatible mobile device (iPhone 6 and upwards); owning a smartwatch is not required.	• Suicidal intent/ideation; score > 2 on Patient Health Questionnaire-9, question 9 • Psychotic illness • Alcohol or drug misuse • Previous diagnosis of an organic mental health disorder • Currently in psychological treatment for depression symptoms • Unstable medication regimens

5.2.4 Support

All patients in the '*Space from Depression*' programme are allocated to a clinician trained in the delivery of SilverCloud iCBT programmes. The clinician is responsible for monitoring and guiding the patient's progress throughout the intervention. At their first login, the patient receives a welcome message from their supporting clinician, highlighting elements of the programme and encouraging them to engage with the programme. Our case study captures the first 8 weeks of treatment, during which on 6 separate occasions the clinician logs in and reviews patients' progress, providing them with feedback on the work they have accomplished. By default, supporters can view patients' weekly goals, key messages, and progress milestones. Patients can also choose to share journal entries with their clinician. At the end of each week in the programme, the clinician provides between 10 and 15 minutes of feedback per patient.

5.2.5 Recruitment

Service users at Berkshire Healthcare were given an initial assessment by phone with a clinician at the IAPT service, and were asked to complete the IAPT Minimum Dataset — a set of self-reported measures assessing current depression and anxiety symptoms, including Patient Health Questionnaire (PHQ-9), Generalized Anxiety Disorder (GAD-7), and Work and Social Adjustment Scale (WSAS). Individuals who were assigned to the '*Space from Depression*' programme were considered for the study. Thereafter, the clinician followed a simple set of instructions to check if a patient's mobile phone was compatible with the study (i.e. iPhone 6 and upwards). For eligible individuals, the clinician described the trial, and invited the patient to participate. If they did not wish to participate, the reason for declining was asked.

5.2.6 Procedure

All eligible patients willing to take part in the study received an email with a link to an online survey. This survey provided them with information detailing the study, and the opportunity to give consent by means of a digital signature. Upon giving consent, participants were asked to provide contact details, socio-demographic details, and answer questions relating to their familiarity with smartwatch technology. Participants who owned a compatible smartwatch were flagged. The online survey ran a simple randomisation algorithm, with a 1:1 allocation ratio to assign each participant to an intervention group. Participants were then shown which study group they had been allocated to. Participants who had been flagged as owning a compatible smartwatch were given the option to use it during the study. All participants were asked to complete the first Acceptance Questionnaire (T1, see Section 5.3.3), capturing their *pre-use acceptability* of the self-monitoring on smartwatch, or on the mobile/desktop app — depending on the study arm they had been assigned to. Participants in the Smartwatch group were sent a study pack, including the Apple Watch SE, simple installation, use, and unpairing instructions, and a pre-paid pre-addressed envelope to return the watch to the IAPT service. The Apple smartwatch had been chosen for this case study as iOS phones were the most widely used

in the UK (over 50% of UK smartphones), and the device incorporated technical capabilities for secure logging and reading of required data (Apple Inc., 2020). Participants taking part with their own smartwatch received simple instructions on how to install and use the Mood Monitor app. The installation process was largely automated, and involved installing the existing SilverCloud Toolkit app from the App store.

During the intervention period, all participants used the '*Space from Depression*' programme, as per normal service procedures with support from a clinician. The Acceptance Questionnaire was repeated at 3 weeks (T2), and at 8 weeks (T3), with minor rewording to account for future/current/previous usage at each time point. In order to minimise non-compliance and drop-out from the study, participants received emails reminding them to complete each Acceptance Questionnaire when they hadn't done so. Participants also completed the Satisfaction with Treatment questionnaire (see Section 5.3.4). At T3, participants who had been lent a smartwatch were asked to unpair it from their mobile phone, and return the smartwatch in the envelope provided. Unpairing the smartwatch deleted all personal data from the smartwatch. Participants were also given instructions on how to delete sleep and physical activity data stored on their own mobile phone, should they wish to do so. Technical support, including issues with installation and unpairing, was available through the SilverCloud platform as normal. Participants were reminded to return the watch with scheduled reminders via phone and email. The reminders emphasised that return of the device would enable other people to participate in similar studies. Returned devices had a factory reset performed to erase all data, whether or not the person had already done this. All participants received a £20 Amazon voucher upon completion of the final Acceptance Questionnaire (T3), and return of the watch for the Smartwatch group. Participants in the Smartwatch group who had indicated consent for the follow-up interview were contacted by phone at the end of the study (8 weeks). Those who took part in the interview received an additional £10 Amazon voucher.

5.3 Longitudinal Measurement of User Acceptance

The primary aim of the case study was to evaluate the level of patient acceptance of the Mood Monitor, its evolution over time, and to identify the facilitators and barriers to acceptance. An additional exploration aimed to explore the potential between-group differences introduced by the addition of the smartwatch, in terms of patient acceptance of self-report, and assess the feasibility of the intervention.

In line with the body of work arguing for considering user acceptance as a multi-stage process (Sekhon et al., 2017; N. Martin et al., 2015; Distler et al., 2018; Terrade et al., 2009; Garces et al., 2016; Somat et al., 2012; Rogers, 1983), we explored a longitudinal evaluation of patient acceptance of self-report on smartwatch. Because of the lack of standardised measurement methods to evaluate acceptance of mental health care technologies discussed in Chapter 2, the proposed methodology to measure acceptance of the Mood Monitor watch app adopts a mixed-methods approach. In an attempt to build a rich picture of user acceptance of the technology, we examine the question through different lenses supported by the literature, namely users' demographics, acceptance mediators, and user satisfaction. We complement these quantitative measures with qualitative insight into user acceptance, by means of additional open-ended questions, and a post-study

interview. Finally, in order to assess for possible differences introduced by the addition of the smartwatch app, we examine participants' use of the '*Space from Depression*' programme use and their clinical outcomes.

5.3.1 Measurement Timeline

Our longitudinal approach to evaluate acceptance considered the three stages of the Technology Acceptance Lifecycle (introduced in Chapter 3): *pre-use*, *initial use*, and *sustained use*. By conducting repeated measures of acceptance following this timeline, we aimed to identify the different facilitators and barriers to user acceptance at each stage, and use this data to inform the design of the technology.

5.3.2 Demographics

As we have seen in Chapter 2's literature review, a large body of work argues for examining user demographics, to enable detection of possible *acceptability* issues in specific user groups, which would impede uptake of the technology. In order to examine possible associations between users' demographics and *pre-use acceptability* of the technology, we asked participants, upon giving consent, to complete socio-demographic details online, including information on gender, age, ethnicity, employment status, marital status, and their experience with the smartwatch technology. For each question, a "Prefer not to answer" option was present.

5.3.3 Acceptance Mediators

The second angle to evaluate user acceptance draws on previous work validating acceptance models, examining user acceptance through the lens of acceptance mediators. This involved selecting among the existing validated acceptance models the best adapted to the population and study context, and measuring its acceptance mediators. To clarify, acceptance models differentiate between *mediators* and *antecedent* factors (also called 'moderators', 'determinants', or 'predictors'). An *antecedent* corresponds to an explanatory variable impacting user acceptance, while a *mediator* represents the mechanism through which the *antecedent* is able to influence user acceptance. For instance, *subjective norm* is a possible antecedent of the mediator *perceived usefulness* (Kim & Park, 2012). Because there presently exists no acceptance model specific to the mental health care context, we decided to draw on the the Health Information Technology Acceptance Model (HITAM) developed by Kim and Park (Kim & Park, 2012). The HITAM includes the following acceptance mediators: *perceived threat*, *perceived usefulness*, *perceived ease of use*, *attitude*, *behavioural intention*, and *usage behaviour*. However, because the study validating the HITAM did not provide the measurement questionnaire used, the application of this model was not straightforward. In order to come up with adapted measurement items for each mediator, we examined questionnaires used in other validation studies and measuring the same mediators, and re-used the questions' wording. This resulted in the proposed Acceptance Questionnaire (AQ) detailed below.

The Proposed Acceptance Questionnaire (AQ)

The Acceptance Questionnaire is presented in Table 5.3. The AQ contains 15 measurement items, statements answerable through a 5-point Likert scale from strongly agree to strongly disagree. In addition, 1 open-ended question assessed the last mediator: *usage behaviour*. This measurement was complemented with the collection of the amount of mood, sleep and activity data recorded by each participant, on each self-report platform. The wording of the AQ was adjusted to the measurement time points. Table 5.3 presents the version of the AQ given to participants at *pre-use* (Day 0, T1); versions given at *initial use* (3 weeks, T2) and *sustained use* (8 weeks, T3) can be found in Appendices F.1 & F.2.

Table 5.3: Acceptance Questionnaire at Day 0 (T1).

Mediators	Item codes	Measurement items	
		Smartwatch group	Control group
Perceived Threat	PT1	I am strongly concerned about my mental wellbeing.	I am strongly concerned about my mental wellbeing.
	PT2	I would make efforts to manage my mental wellbeing.	I would make efforts to manage my mental wellbeing.
Perceived Usefulness	PU1	I think that keeping track of my mood with the watch app will help in managing my mental wellbeing.	I think that keeping track of my mood with the programme will help in managing my mental wellbeing.
	PU2	I think that keeping track of my sleep and physical activity automatically will help in managing my mental wellbeing.	I think that keeping track of my lifestyle choices, such as sleep and physical activity, with the programme will help in managing my mental wellbeing.
	PU3	Overall, I think that the watch app will be useful in managing my mental wellbeing.	
Perceived Ease of Use	PEOU1	I think that keeping track of my mood with the watch app will be easy.	I think that keeping track of my mood with the programme will be easy.
	PEOU2	I think that keeping track of my sleep and physical activity with the watch app will be easy.	I think that keeping track of my lifestyle choices, such as sleep and physical activity, with the programme will be easy.
	PEOU3	My interaction with the watch app will be clear and understandable.	
	PEOU4	I think that the watch app will be easy to use.	
Attitude	A1	I will be comfortable recording my mood data with the watch app.	I will be comfortable recording my mood data with the programme.
	A2	I will be comfortable recording my sleep and physical activity data with the watch app.	I will be comfortable recording my lifestyle choices, such as sleep and physical activity, with the programme.
	A3	I will be comfortable sharing my mood data with my SilverCloud Health supporter.	I will be comfortable sharing my mood data with my SilverCloud Health supporter.
	A4	I will be comfortable sharing my sleep and physical activity data with my SilverCloud Health supporter.	I will be comfortable sharing my lifestyle choices, such as sleep and physical activity, with my SilverCloud Health supporter.
Behavioural Intention	BI1	I intend to use the watch app until completion of my treatment.	I intend to track my mood and lifestyle choices, such as sleep and physical activity, when prompted by the programme until completion of my treatment.
Usage Behaviour	UB1	I decided to use the watch app because ...	I decided to enrol in this study because ...

5.3.4 Patient Satisfaction

Chapter 3 showed that user satisfaction was often considered a factor of acceptance of digital health (Schlosser et al., 2017; McManama O'Brien et al., 2017; Brittain et al., 2018; Eisenhauer et al., 2017; Niendam et al., 2018). In our case study, we were interested in possible associations between long-term technology acceptance and patient satisfaction. At 8 weeks along with the third AQ, we asked participants to complete the Satisfaction with Treatment measure (Richards & Timulak, 2013), a 5-item questionnaire which has been used previously to evaluate patient satisfaction with the '*Space from Depression*' intervention (Richards & Timulak, 2013).

5.3.5 Facilitators & Barriers to Acceptance

To identify the specific facilitators and barriers to user acceptance of the Mood Monitor watch app, we asked patients in the Smartwatch group additional open-ended questions, and gave them the opportunity to take part in a post-study interview to discuss their experience.

Open-Ended Questions

At each measurement time point, participants were given the opportunity to write about their experience with the Mood Monitor watch app. At T1 (*pre-use*), the open-ended question at the end of the AQ assessed patients' *usage behaviour*, asking them the reasons why they had decided to use the watch app and enrol in the study. At T2 (*initial use*), participants were asked "How would you describe your use of the watch app?" and "What difficulties (if any) did you experience while installing or using the Mood Monitor app?". At T3 (*sustained use*), participants were asked a few additional open-ended questions (see Tab. 5.4), exploring supplementary acceptance factors which, according to previous research, might impact patient acceptance: satisfaction (Schlosser et al., 2017; McManama O'Brien et al., 2017; Brittain et al., 2018; Eisenhauer et al., 2017; Niendam et al., 2018), *engagement* (Rizvi et al., 2016; Simmons et al., 2016), *recommendation rate* (Schlosser et al., 2017; Simmons et al., 2016; Bucci et al., 2018; Juarascio et al., 2015), *sharing* (McCallum, Rooksby, & Gray, 2018), *privacy protection* (Cheung et al., 2019), *resistance to change* (Dou et al., 2017), and *match with expectations* (Schlosser et al., 2017).

Post-Study Interview

In an effort to complement qualitative data collected in the three questionnaires, we conducted semi-structured interviews further exploring the facilitators and barriers to patient acceptance of the self-report on smartwatch. Patients who had provided consent were contacted at 8 weeks and invited to participate in the interview. Out of the 26 patients invited, 8 took part in the interview (5 Females, 3 Males). Patients taking part in the interview were informed that the interviewer was a researcher and not a clinician, and briefed on the risk management procedure in place — which consisted of reporting the patient to the service emergency line if they appeared to be at risk.

Table 5.4: Open-ended questions for the Smartwatch group at 8 weeks (T3).

Mediators	Measurement items
Match with expectations	How was the experience of using the watch app?
Engagement	How did the watch app impact how you used the ‘ <i>Space from Depression</i> ’ intervention?
Recommendation	If you would recommend (or not) the watch app to other people using the ‘ <i>Space from Depression</i> ’ programme, could you explain why?
Sharing	How would you expect your supporter to use the information gathered through the app?
Perceived privacy	How comfortable did you feel using the watch app in your daily life? When did you feel more/less comfortable using it?
Resistance to change	If you felt reluctant (or keen) to use the watch app, could you explain why?
Possible negative experience	If there were any negative aspects to your use of the watch app, could you describe these?
Watch app features	How did you feel about the reminders to record your mood? How did you feel about the ‘ <i>Tips to Stay Well</i> ’ (accessible from app menu)? How did you feel about the encouragement prompts? If you haven’t encountered any, how would you have liked to be encouraged/rewarded while using the watch app?
General feedback	What do you feel could be improved about the watch app?

5.4 Other Measurements – Exploring Acceptance in a Multi-Arm Context

The ‘*Space from Depression*’ iCBT programme habitually provides a means to self-report mood and lifestyle habits on desktop and smartphone. Therefore, the acceptance scores of participants in the control group not only represents individuals’ acceptance of this delivery means for self-report, but also provides a control condition to assess whether the introduction of the smartwatch affects patient acceptance of self-report. Although the introduction of smartwatch as additional platform to self-report constitutes as small addition to the complex system of the iCBT intervention, it is still important to explore its potential impact on patients’ use of the programme, and on their clinical outcomes. At a higher-level, this exploratory analysis may provide valuable insight into the particularities of conducting user acceptance research in multi-arm settings.

5.4.1 User Acceptance

Comparing user acceptance of self-report in both groups has the potential to inform on the impact of the introduction of the smartwatch on patient acceptance of this particular intervention component. However, because the smartwatch app constitutes an *addition* to the routine intervention, this comparison is not straightforward, and the issue was extensively discussed among the research team. Indeed, it would have been inaccurate to compare acceptance of the addition that constitutes the smartwatch app, with the

control group’s acceptance of the overall intervention. To address this difficulty and enable between-group comparison, the wording of the AQ focused on the self-monitoring component of the intervention, with the only difference between groups being the delivery platform (smartwatch vs desktop/mobile app). However, because patients in the control group would likely struggle to distinguish the different components of the programme — and particularly to anticipate what the self-monitoring component would be like before starting the programme (*pre-use*) — three measurement items in the Smartwatch group’s questionnaire (PU3, PEOU3, and PEOU4) find no correspondence in the control group’s questionnaire. Therefore, in order to compare the acceptance scores in both groups, we considered a subset of 12 identical questions.

5.4.2 Use of Self-Report

Comparing use of the technology — in our case, the self-report component of the iCBT intervention — between the intervention and control groups has the potential to reveal how the degree of acceptance in both groups translates (or not) into actual use of technology. We collected the number of mood entries each participant recorded on the smartwatch and the desktop/mobile app, as well as the number of sleep and exercise record for each patient. Additionally, the number of times each participant accessed the ‘Tips to Stay Well’ feature was recorded.

5.4.3 Feasibility Assessment

This study is pragmatic as it is embedded within an existing service. To assess the impact of adding the smartwatch app in the iCBT intervention, we collected additional metrics.

Use of the iCBT Programme

We compared usage of the program in the Smartwatch and control groups with the following metrics.

Total time on the platform. This measure is the combination of the time spent in each session (in min) from the first to the last log-in. Time per session is calculated by taking the time from when the user logged in, to the last action the user performed in the platform, irrespective of when the session was closed.

Number of sessions. This measure corresponds to the number of times the user accessed the programme. After 1 hour of inactivity, the user is automatically logged out and they will be asked to log in again, which counts as a different session.

Number of tools used. This measure refers to the number of tools, out of the 9 available in the programme, employed at least once by the user.

Percentage of the programme viewed. This measure relates to the percentage of the total programme content that the user has gone through.

Number of reviews. This measure reports the number of messages that the supporter sent to the user to encourage use of the platform and provide feedback about the progress from the last review.

Clinical Outcomes

In order to determine the possible impact of the integration of the smartwatch app on patients' clinical outcomes, we compared the clinical scores of participants in both groups, obtained pre and post study. Indeed, the trial followed the usual procedures for IAPT, which included routine clinical assessments of patients. Thus, participants were routinely assessed using the Patient Health Questionnaire (PHQ-9), Generalized Anxiety Disorder (GAD-7), and Work and Social Adjustment Scale (WSAS) as part of the Minimum Dataset administered by IAPT (Service, 2011). The assessment was assigned before each review with a clinician, and completed by the patient. These assessments constituted patients' continuous treatment outcome scores.

Patient Health Questionnaire-9 (PHQ-9). The PHQ-9 is a nine-item self-report measure of depression (Kroenke, Spitzer, & Williams, 1999, 2001) that has been widely used in research and is employed as a clinical outcome measure in IAPT as part of its Minimum Dataset. The PHQ-9 items correspond to the diagnostic criteria for depression defined by the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (Edition et al., 2013).

Generalized Anxiety Disorder-7 (GAD-7). The GAD-7 (Spitzer, Kroenke, Williams, & Löwe, 2006) is used nationally as a screening and outcome measure in IAPT and is part of the Minimum Dataset. The seven items measuring anxiety symptoms and severity correspond to the DSM-Fifth Edition diagnostic criteria for general anxiety disorder (Edition et al., 2013).

Work and Social Adjustment Scale (WSAS). This is a five-item self-report questionnaire of functional impairment (Mundt, Marks, Shear, & Greist, 2002) that is employed nationally as an outcome measure in IAPT. It examines the experiential impact of a disorder across different life domains from the perspective of the service users. The questionnaire examines the degree of impairment caused by a disorder on a daily basis across five dimensions: work, social life, home life, private life, and close relationships.

5.5 Discussion

The design of the case study protocol for the evaluation of user acceptance in a clinical mental health care context was particularly challenging. This section reflects on the issues faced, and the design decisions made to address them.

5.5.1 Finding an Adapted Measurement Tool

As highlighted in Chapter 2, there is no validated tool for the measurement of user acceptance of mental health technologies. Therefore, to develop the measurement tool used in our case study, we relied on existing theories and models addressing user acceptance in the health domain. Drawing on our review of the literature, we selected Kim and Park's HITAM model (Kim & Park, 2012) for it appeared to be the most advanced health technology acceptance model, inclusive of previously uncovered acceptance factors. However, the validation

study for this model relied on a 50-item questionnaire, which was not provided by the authors. This posed two problems. Firstly, the particular vulnerability of our user group (patients starting a depression treatment), and the repeated measures involved in evaluating their acceptance of technology were two strong motivations to use a shorter questionnaire. Secondly, in order to incorporate standardised questions into our measurement tool, we had to consider and re-use the wording other validated questionnaires examining the same acceptance factors. We eventually developed a set of 15 measurement items, which corresponds to the average number of questions used in the validation studies reviewed.

In addition, because of the gap in the theory, we were unsure whether the HITAM mediators would indeed cover all factors at play in user acceptance of mental health care technologies. Therefore, we made the decision to explore additional mediators validated by the literature by means of open-ended questions.

To conclude, when attempting to conduct studies evaluating acceptance, researchers might face issues pertaining to (i) the lack of theoretical models to guide measurement, and (ii) available measurement tools that are not adapted to the study context, particularly when investigating acceptance in a mental health context.

5.5.2 Measuring Acceptance Longitudinally

Chapter 2 revealed a growing body of work on the importance of measuring acceptance at specific stages of the user journey — *pre-use*, *initial use*, and *sustained use* — which we have articulated in the TAL model (Chapter 3 Section 3.3.4). While the distinction between *pre* and *post-use* is quite straightforward because materialised by the action of use, existing theoretical frameworks don't provide guidelines as to when *initial use* becomes *sustained use*. Deciding the timing of acceptance measures at these two stages for the case study protocol therefore elicited many discussions in the research team. The complex nature of clinical trials — particularly those involving use of hardware — also created additional constraints to the longitudinal measurement of acceptance. Particularly, in order to capture *initial use acceptance* — discovery of the features and possible interactions with the system by the user — the questionnaire needed to be sent after the participant had received the smartwatch and had started interacting with it, but it needed to be deactivated before the participant entered the *sustained use* stage. Collaboration with the mental health service providers on the ground was crucial to determine the most appropriate timing for this measurement point. Variables such as potential postal delays in the delivery of the watches, patient sign up process and usual engagement with the iCBT programme, were gauged to schedule the questionnaire delivery. While an effort of the research community is needed to provide guidance as to when *initial use* becomes *sustained use*, health and mental health researchers also need to consider the parameters specific to their study design when planning their measurement timeline.

5.6 Limitations

Randomised controlled trials are often used as means to evaluate the feasibility and efficacy of new mental health interventions. They therefore present opportunities for the longitudinal study of acceptance. In studies examining the replacement of a service with a digital alternative, comparing user acceptance across control and intervention group is straightforward. However, studies of a different nature might require adjustment of the measurement approach. For instance, our case study examining the addition of a platform (the smartwatch) to facilitate patient self-monitoring in an existing iCBT intervention, implied that both groups had access to the same digital intervention, but the intervention group had an additional access to a self-report smartwatch app. In such study setups, it would be inaccurate to compare acceptance of the overall intervention across groups, as doing so would equate to comparing ‘A versus A+B’, as opposed to ‘A versus B’. To address this challenge in conducting multi-arm studies on acceptance, we argued for comparing patient acceptance of specific components within the intervention. This resulted in adjusting the wording of the Acceptance Questionnaire for the control group, so that it would focus on the mood and lifestyle habits self-report component (which both groups had access to) in order to enable between-group comparison. We acknowledge that this comparison is not straightforward, and emphasise the difficulty of comparing a service vs. the same service with an addition. In other instances where the introduction of technology is creating a new service, no comparison baseline exists. Thus, examining user acceptance in such studies should only focus on the intervention group.

5.7 Conclusion

This chapter proposed a novel, theory-based longitudinal approach to evaluating user acceptance following the TAL timeline, and discussed the issues associated with the implementation of this method in a clinical mental health care context. We have described the protocol for case study exploring this longitudinal evaluation method, by means of an 8-week randomised controlled clinical trial evaluating user acceptance of a self-monitoring technology in patients undergoing depression treatment. Finally, we have reflected on the challenges of designing studies for the longitudinal evaluation of user acceptance research in a clinical context. The clinical case study was conducted from December 2020 (start of recruitment) to August 2021 (end of data collection). The results of this trial and a reflection on the conduct of user acceptance research in clinical settings are presented in the next chapter.

Chapter 6

Interpreting the Longitudinal Evaluation of Patient Acceptance

The previous chapter proposed a novel, theory-based longitudinal approach to evaluating user acceptance, and described the protocol for a case study exploring this method by means of a randomised controlled clinical trial. In this chapter, we first analyse the case study results, before reflecting on the process of evaluation of user acceptance in clinical contexts. Through the analysis of the trial's results, the present chapter provides a practical example of data analysis showing how this longitudinal measurement approach can inform the technology design. Particularly, it identifies a set of implications for designing self-monitoring clinical interventions on smartwatch. Finally, drawing on the findings, this chapter discusses the challenges of conducting user acceptance research in clinical settings, in terms of alignment with existing acceptance models and the emergence of new perspectives, and a reflection on the measurement methods and on the conduct of such research in clinical settings. This chapter therefore constitutes a second contribution to answering the third Research Question¹. This work is a collaboration with two clinical teams. I conducted the study in accordance to the study protocol, managed patient recruitment and data collection, curated and analysed the data, and managed the project. Caroline Earley acted as liaison with the clinical team in Dublin, helped administer the project and liaised with the clinicians at the NHS site who recruited patients for the study. Dr Angel Enrique provided feedback on the quantitative data analysis.

6.1 Participants

As described in the previous chapter, patients' eligibility was determined at their initial assessment with a clinician. A total of 155 patients were assessed eligible and invited to participate. Among them, 70 patients did not follow through with the invite, while 14 explicitly declined it. Eligibility assessment thus resulted in

¹RQ3: How can we evaluate user acceptance longitudinally, in a mental health care context, and draw on the results to inform the technology design? What are the challenges of conducting user acceptance research in clinical settings?

71 patients recruited for the study, among which 2 withdrew, bringing the total number to 69 participants. The composition of the two arms was the following: 35 participants in the Smartwatch group, and 34 in the control group. Participant demographics are described in Table 6.1. The flow diagram (see Fig. 6.1) shows the flow of participants through each stage of the study.

Table 6.1: Demographic characteristics of study participants.

Characteristic	Total sample (N=69), n (%)	Smartwatch group (N=35), n (%)	Control group (N=34), n (%)
Gender			
Female	48 (69.6)	23 (48)	25 (52)
Male	20 (28.9)	12 (60)	8 (40)
Nonbinary	1 (1.5)	0 (0)	1 (100)
Age group (years)			
18-24	26 (37.6)	10 (38)	16 (62)
25-34	24 (34.8)	12 (50)	12 (50)
35-44	10 (14.5)	7 (70)	3 (30)
45-54	8 (11.6)	5 (63)	3 (37)
Over 55	1 (1.5)	1 (100)	0 (0)
Ethnicity			
Asian or Asian British	10 (14.5)	7 (70)	3 (30)
Black or Black British	4 (5.8)	1 (25)	3 (75)
Mixed	3 (4.3)	1 (33)	2 (67)
White	52 (75.4)	26 (50)	26 (50)
Relationship status			
Cohabitant	10 (14.5)	6 (60)	4 (40)
Divorced / civil partnership dissolved	5 (7.3)	3 (60)	2 (40)
Married / in civil partnership	20 (28.9)	12 (60)	8 (40)
Single	32 (46.4)	12 (38)	20 (62)
Not disclosed	2 (2.9)	2 (100)	0 (0)
Level of education			
A-Levels or equivalent	30 (43.5)	17 (57)	13 (43)
GCSEs or equivalent	6 (8.7)	2 (33)	4 (67)
Other	2 (2.9)	1 (50)	1 (50)
University or college degree	30 (43.5)	15 (50)	15 (50)
Not disclosed	1 (1.4)	0 (0)	1 (100)
Employment			
Employed, full time	37 (53.6)	20 (54)	17 (46)
Employed, part-time	11 (16)	5 (45)	6 (55)
Not employed, looking for work	9 (13)	5 (56)	4 (44)
Not employed, not looking for work	4 (5.8)	0 (0)	4 (100)
Self-employed	6 (8.7)	5 (83)	1 (17)
Not disclosed	2 (2.9)	0 (0)	2 (100)
Smartwatch ownership	21 (30)	11 (31)	10 (29)

6.2 Data Analysis

As described in the previous chapter, this research gathered a mix of quantitative and qualitative data. We describe here the method adopted to analyse this rich dataset.

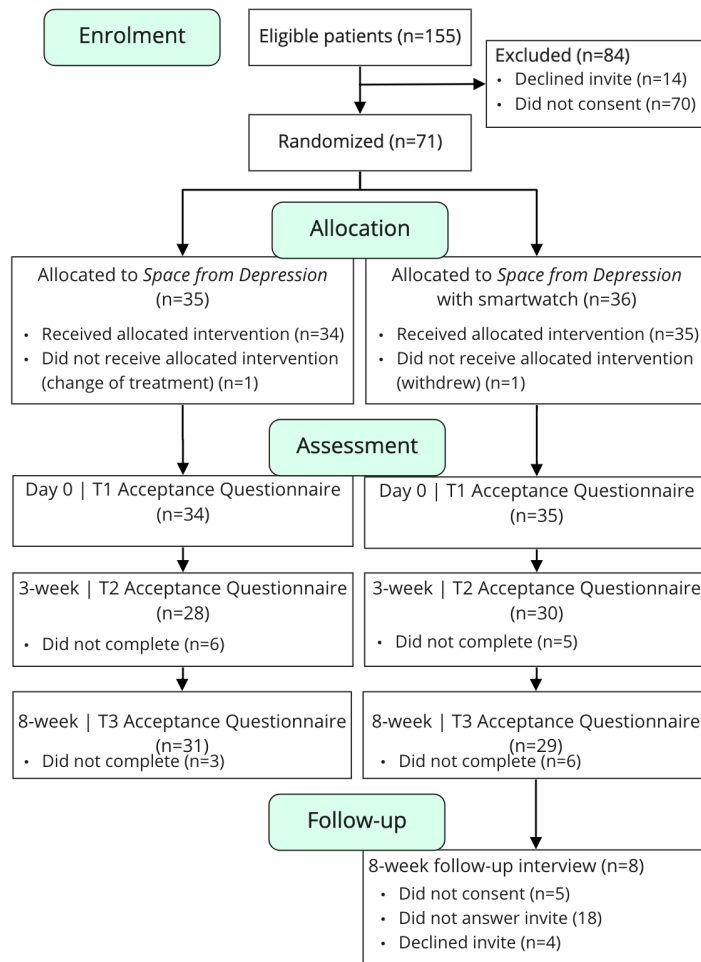


Figure 6.1: Participant flow diagram.

6.2.1 Evaluating Acceptance

Answers to the AQ were collected at T1 (SW=35, Control=34), T2 (SW=30, Control=28), and T3 (SW=29, Control=31), and internal consistency of the questionnaire was calculated through Cronbach's alpha coefficient. The different versions of the Acceptance Questionnaire (for each intervention group and measurement point) presented a high reliability, with all Cronbach's alpha coefficients greater than .7 (see Tab. 6.2).

Table 6.2: Cronbach's alpha coefficients for each version of the Acceptance Questionnaire.

Group	Acceptance Questionnaire		
	T1	T2	T3
Smartwatch	.864	.771	.823
Control	.806	.944	.888

Participants demographics were analysed through descriptive statistics. The potential influence of demographics on *pre-use acceptability* scores (T1) was assessed with Kruskal-Wallis tests (non-normal distribution).

Acceptance scores at T1, T2, and T3 were analysed through descriptive statistics, to observe patient overall acceptance, its evolution over time, and the specific role of each acceptance mediator (e.g. perceived usefulness). In addition, repeated-measures ANCOVA were used to evaluate significant differences in the acceptance score to each mediator, at *pre-use* (T1), *initial use* (T2) and *sustained use* (T3), while controlling for

the effects of relevant demographic variables.

Patients' use of self-report on smartwatch was analysed through descriptive statistics. Use of self-report on smartwatch was compared with that of self-report on desktop/mobile app with a Mann-Whitney U test (non-normal distribution). Descriptive statistics are presented for participants' use of the Tips to Stay Well feature on the smartwatch app.

Patient satisfaction with treatment was observed through descriptive statistics. Its potential influence on long-term acceptance was analysed with a Pearson correlation coefficient.

6.2.2 Identifying Facilitators & Barriers to Acceptance

The 8 follow-up interviews were audio recorded for a total of 3h14m of audio (with an average of 24min per participant). These recordings were then anonymised and transcribed. The open-ended questions asked at T1, T2, and T3, and during the interviews were directly inspired from existing theories of user acceptance. We analysed participants answers following Swain's hybrid analysis approach (Swain, 2018), combining theoretical thematic analysis with inductive thematic analysis (Braun & Clarke, 2012), in order to account for both the theories grounding our approach, and the possible emergence of unexplored factors linked to the acceptance of mental health technologies. This method implies the use of a priori, theory-driven codes, and the generation of a posteriori, data-driven codes, accounting for novel information from the data set. First, a priori codes were generated from the acceptance concepts identified in Section 5.3.3 (i.e. *perceived usefulness*, *perceived ease of use*, etc.) and the acceptance theories identified in the literature review. Then, we proceeded with 1) getting familiar with the data, 2) coding the data through the template of a priori codes, 3) looking for new meaning in the data and generating a posteriori codes, 4) identifying patterns across all codes, and 5) defining themes and reporting the results.

6.2.3 Assessing Between-Group Differences & Feasibility

Between-group differences with regard to use of self-report of mood, sleep and physical activity were analysed through descriptive statistics. Significance was assessed with Mann-Whitney U tests (non-normal distribution). With regard to use of the programme, between-group differences in terms of the total time on the platform, number of sessions, number of tools used, percentage of the programme viewed, and number of reviews were analysed through descriptive statistics. Significance was evaluated with t-tests (normal distribution) and Mann-Whitney U tests (non-normal distribution). The specific number of moods recorded were assessed by means of independent-samples t-test analyses, or non-parametric Mann-Whitney tests if the data was not normally distributed. Finally, two-way repeated measures ANOVA were conducted to assess between-group differences on change in the clinical effectiveness measures (i.e. PHQ-9, GAD-7, WSAS) from pre to post-treatment, while accounting for missing data. Where extreme legitimate outliers were identified, they were *winsorized* to the closest highest (in the lower tail) and lowest (in the upper tail) value, following Bruce Blaine's approach (Blaine, 2018).

6.3 Evaluating Acceptance through Demographics, Acceptance Mediators & Patient Satisfaction

This section aims to build a rich picture of user acceptance, for the particular case of self-report on smartwatch. Drawing on existing theories, we consider patient acceptance of the technology through different lenses. First, we provide an insight on the evolution of patients’ overall acceptance of self-report on smartwatch, through the acceptance scores obtained at *pre-use*, *initial use*, and *sustained use*. Second, we look into possible associations between users’ demographics and *pre-use acceptability* of the technology (i.e users’ level of acceptance before first use of the technology), which is suggested by the literature. Next, we further examine the acceptance scores at *pre-use*, *initial use*, and *sustained use*, through the lens of the set of acceptance mediators forming the theoretical basis of the acceptance questionnaire. Lastly, we investigate possible associations between patient satisfaction with treatment and acceptance of the technology, as suggested by previous acceptance studies. Figure 6.2 details the different steps of this analysis.

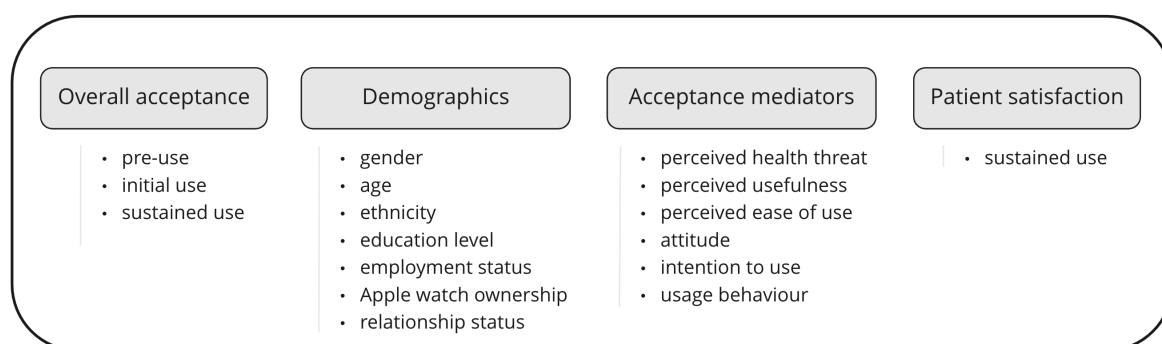


Figure 6.2: Steps of the analysis, each looking at an aspect of user acceptance suggested by the literature.

6.3.1 Evolution of Overall Patient Acceptance

Examining the evolution of patient acceptance over time, through the three Acceptance Questionnaire scores, has the potential to inform on users’ trajectories with the technology. A significant improvement in the acceptance score over time might, for instance, indicate appearance of an element in the user journey facilitating acceptance — e.g. users starting to enjoy using the system (increased *perceived playfulness*) — or disappearance of a barrier to acceptance — e.g. users feeling less apprehensive toward using it (decreased *technology anxiety*). And conversely for a significant decline in the acceptance score.

We therefore looked at participants’ scores from the Acceptance Questionnaire given at *pre-use* (Day 0), *initial use* (3 weeks), and *sustained use* (8 weeks). This longitudinal measure of acceptance revealed that patient acceptance of self-report on smartwatch started and remained high throughout the 8 weeks (see Fig. 6.3 presenting an overview of the Smartwatch group’s scores).

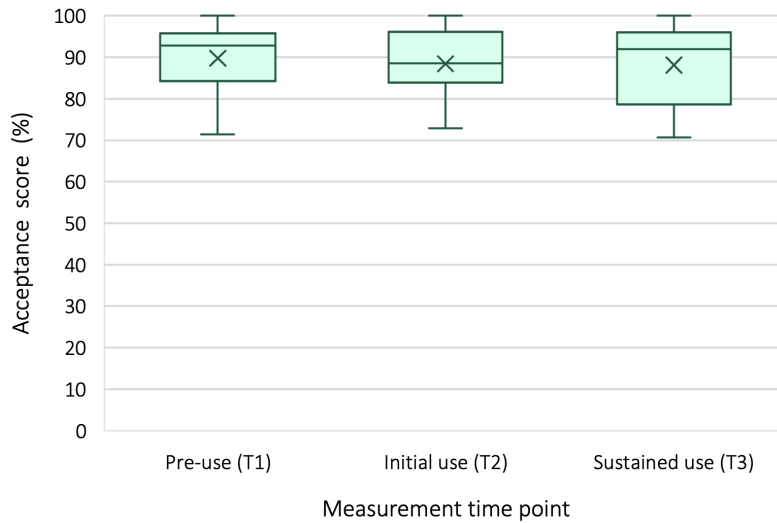


Figure 6.3: Acceptance scores of the Smartwatch group at *pre-use*, *initial use*, and *sustained use*. Mean scores are represented by a 'x' and median score by a line.

Pre-use acceptability scores (n=35) ranged from 71 to 100% (M=89.80, SD=7.993). *Initial use acceptance* scores (n=30) ranged from 73 to 100% (M=88.38, SD=7.956). *Sustained use acceptance* scores (n=27) ranged from 71 to 100% (M=88.10, SD=9.636). An ANOVA test showed no evidence of a statistically significant difference between the scores across the three time points ($F(2, 48)=.611, p=.547$). This result confirms that the addition of the smartwatch app did not introduce serious issues in user acceptance. We later compare this result with user acceptance of self-report in the control group, in order to check for significant differences (see Section 6.5.1). While this high rate of acceptance being maintained across the three time points is supportive of this use of technology, an interesting question arises regarding the interpretation of these measurements: if dramatic improvements or decreases in acceptance were observed, to what would we attribute these changes?

6.3.2 Demographics & Pre-Use Acceptability

As we have seen in Chapter 2's literature review, a large body of work argues for examining user demographics, as to detect possible acceptability issues in specific user groups, which would impede uptake of the technology. We therefore explored the possible impact of the Smartwatch group participants' demographics (i.e. gender, age, ethnicity, education level, employment status, Apple watch ownership, and relationship status) on their *pre-use acceptability* scores (T1). The scores were non-normally distributed, therefore Kruskal-Wallis tests were used. Two thirds of the participants in the Smartwatch group identified as Female, while a third identified as Male (see Fig. 6.4). This proportion is representative of the gender gap that exists in IAPT patients (Sagar-Ouriaghi, Godfrey, Graham, & Brown, 2020), and in mental health care generally (Cole & Ingram, 2020). There was no evidence of a statistically significant difference between patients' gender and their acceptability score (Kruskal-Wallis $\chi^2=2.755, df=1, p=.097$).

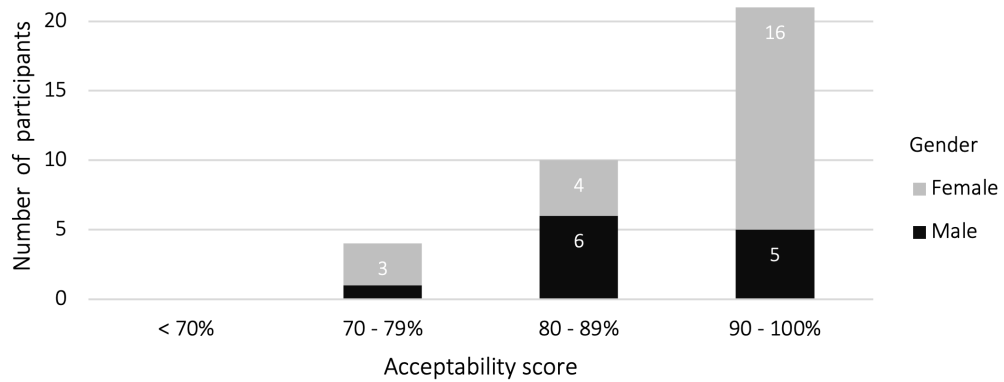


Figure 6.4: Pre-use acceptability score (T1) by gender.

The majority of participants (22) were under 35 years old, while very few participants (3) were over 45 years old (see Fig. 6.5). There was no evidence of statistically significant difference between patients' age and their acceptability score (Kruskal-Wallis $\chi^2=2.853$, $df=4$, $p=.583$).

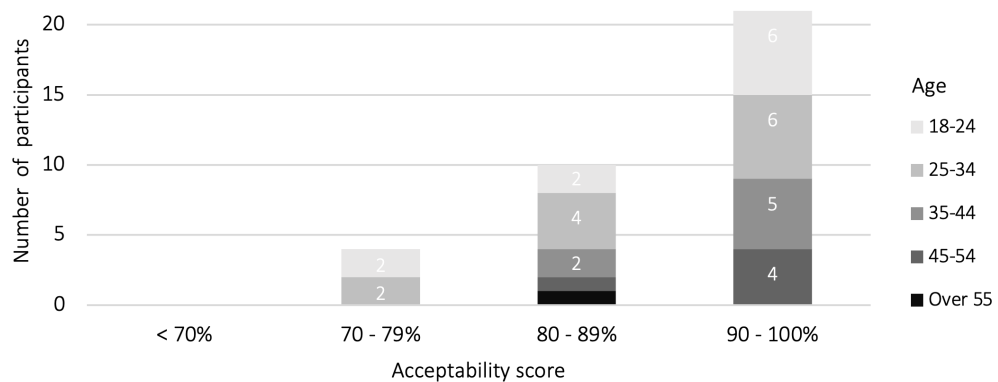


Figure 6.5: Pre-use acceptability score (T1) by age.

When asked about their ethnicity, about a fourth of participants (9) identified as Black, Asian and Minority Ethnic, while the remaining (26) identified as White (see Fig. 6.5). There was no evidence of statistically significant difference between patients' ethnicity and their acceptability score (Kruskal-Wallis $\chi^2=.207$, $df=1$, $p=.649$).

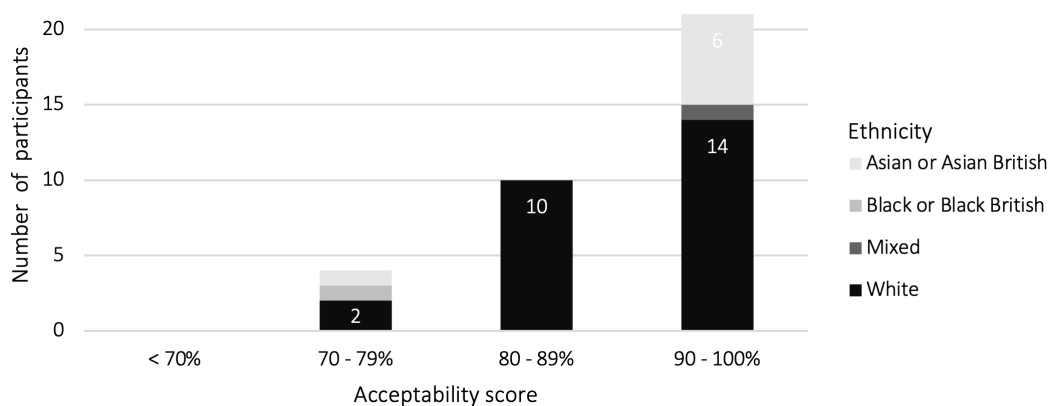


Figure 6.6: Pre-use acceptability score (T1) by ethnicity.

Answers about the education level revealed that most participants held an A-Levels or equivalent (17), or a university degree (15), see Figure 6.7. There was no evidence of statistically significant difference between patients' education level and their acceptability score (Kruskal-Wallis $\chi^2=4.582$, $df=3$, $p=.205$).

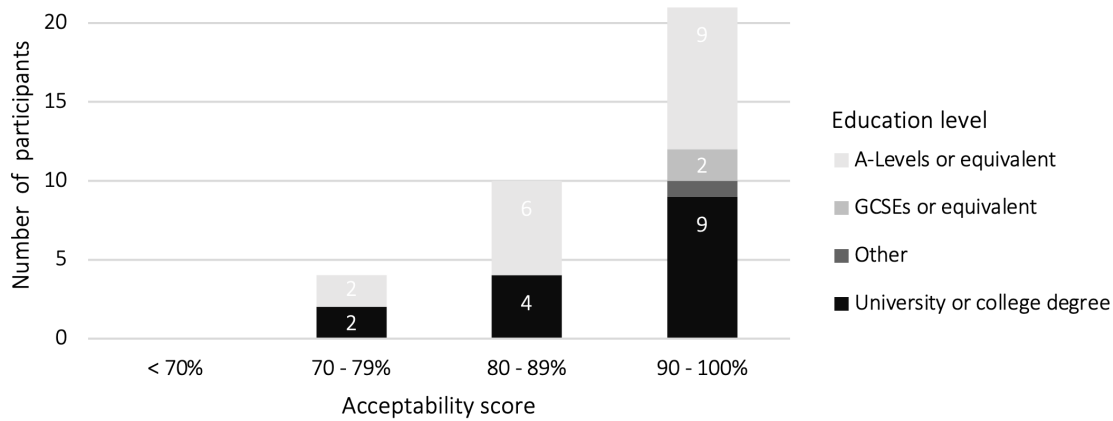


Figure 6.7: Pre-use acceptability score (T1) by education level.

The majority of participants reported being employed at full or part time (25), while some were looking for work (5), and others (5) were self-employed (see Fig. 6.8). There was no evidence of statistically significant difference between employment status and patient acceptability score (Kruskal-Wallis $\chi^2=1.244$, $df=3$, $p=.743$).

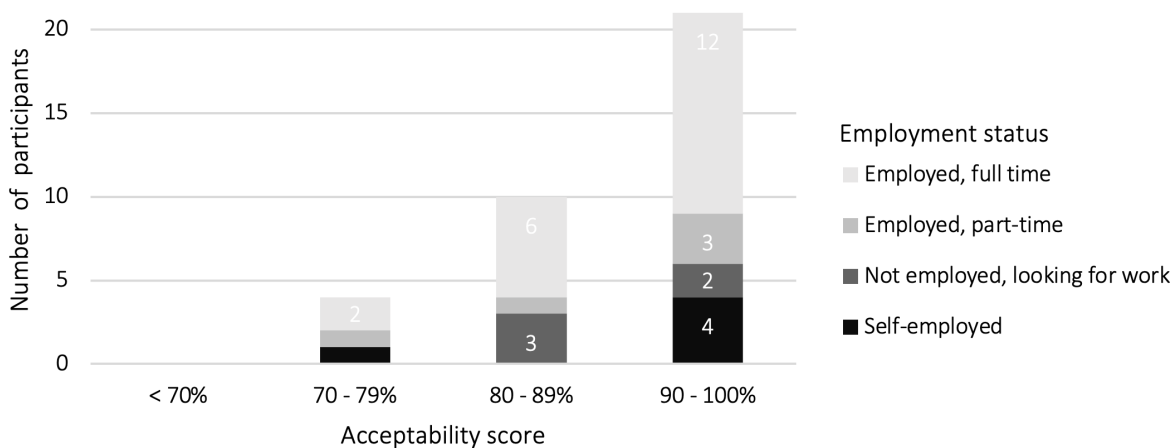


Figure 6.8: Pre-use acceptability score (T1) by employment status.

Over a fourth of participants (11) owned an Apple watch, while the rest of the group (24) did not (see Fig. 6.9). There was no evidence of statistically significant difference between patients' ownership of an Apple watch and their acceptability score (Kruskal-Wallis $\chi^2=.0$, $df=1$, $p=.986$).

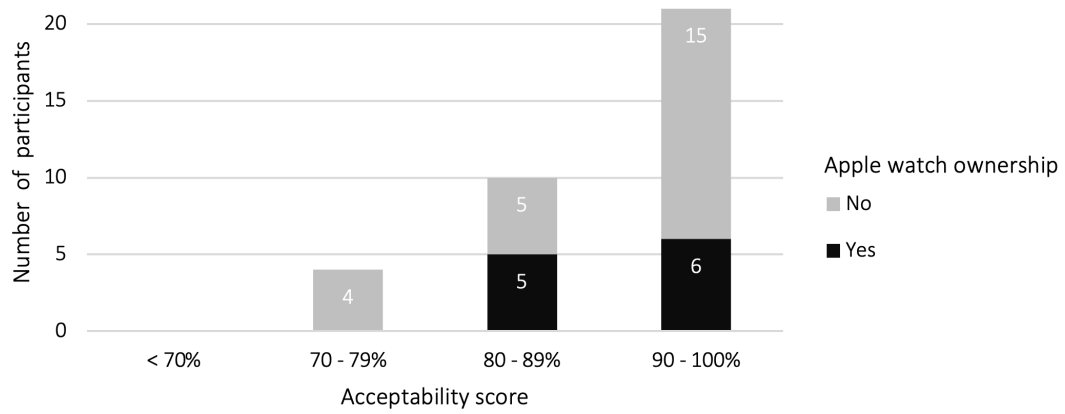


Figure 6.9: Pre-use acceptability score (T1) by Apple watch ownership.

An equal number of participants (12) were either single, or married/in a civil partnership, while others were cohabitant (6), and a minority (1) divorced (see Fig. 6.10). There was evidence of a statistically significant difference in the acceptability scores of participants who declared being single, and those married/in a civil partnership (Kruskal-Wallis $\chi^2=8.762$, $df=3$, $p=.033$). A Dunn's pairwise comparisons test confirmed this significant difference ($p=.021$). Therefore, patients who declared being married or in a civil partnership were more likely to have a higher acceptability score, compared to those single. This result reveals the presence of facilitators of acceptance in the former group, or barriers in the latter. Although determining these factors would require further investigation, we can hypothesise that the antecedents *social support* and/or *social pressure* (Venkatesh, 2000; Venkatesh et al., 2003; Venkatesh & Bala, 2008; Venkatesh et al., 2012; Kim & Park, 2012; Cheung et al., 2019) might act as facilitators of patients' uptake of the self-report on smartwatch.

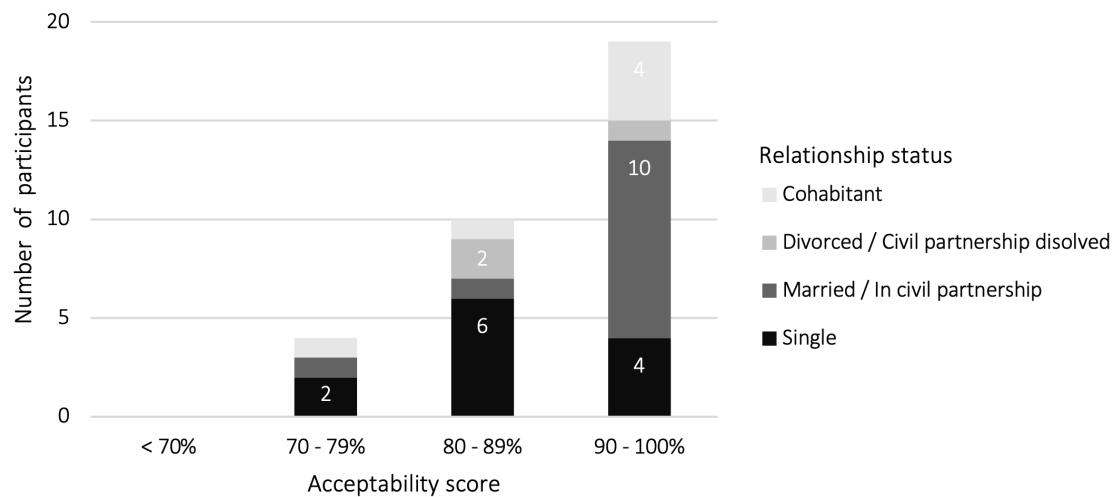


Figure 6.10: Pre-use acceptability score (T1) by relationship status.

6.3.3 User Acceptance through the Lens of Acceptance Mediators

The acceptance mediators assessed in the Acceptance Questionnaire drew on the HITAM (Kim & Park, 2012). They include *perceived threat*, *perceived usefulness*, *perceived ease of use*, *attitude*, and *behavioural intention* (see Sect. 5.3.3). Examining the repeated score to each of these factors (T1, T2, T3) has the potential to indicate

where might lie facilitators or barriers to acceptance, and how these evolve through use of the technology. A specific acceptance score for each mediator was obtained by calculating the average of the participant's score to the Likert scale questions measuring that mediator. This resulted in an acceptance score, for each mediator, ranging from a minimum of 1 to a maximum of 5. Figure 6.11 gives an overview of the evolution of patients' scores to each acceptance mediator, revealing that the average score for all mediators was high (superior to 4/5), and quite stable across the user journey.

Next, we considered the acceptance mediators individually, assessing the evolution of the mean score over time. We checked for significant differences at *pre-use* (n=35), *initial use* (n=30), and *sustained use* (n=27), by performing a repeated-measures ANCOVA (controlling for the effects of the relationship status variable)².

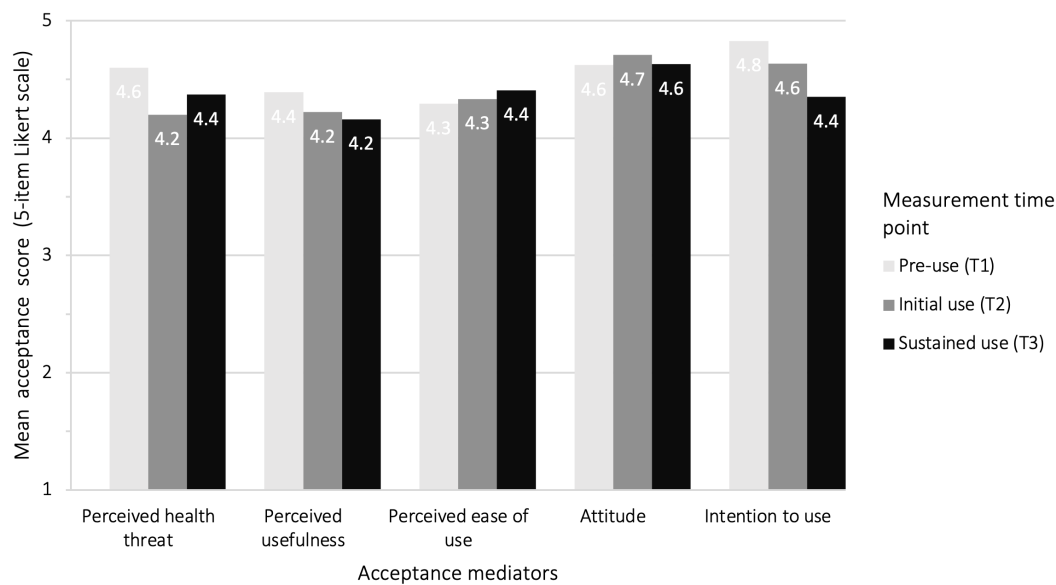


Figure 6.11: Smartwatch group scores to the acceptance mediators, at *pre-use*, *initial use*, and *sustained use*.

Perceived Threat

The *perceived threat* mediator reflects users' concerns about their mental health, and their willingness to take action to get better (Kim & Park, 2012). The repeated measures show that the *perceived threat* remained high throughout the intervention. Scores ranged from 3.0 to 5.0 (M=4.600, SD=.4971) at *pre-use*, from 1.5 to 5.0 (M=4.200, SD=.7611) at *initial use*, and from 2.5 to 5.0 (M=4.370, SD=.6877) at *sustained use* (see Fig. 6.12). There was no evidence of a statistically significant difference between the scores across the three time points ($F(2, 44)=3.122, p=.054$), which means that patients' mental health concerns remained throughout treatment, and so did their will to improve. Because a significant change in *perceived threat* — and therefore in overall technology acceptance — could be a result of improved/worsened clinical outcomes, examining patients' clinical trajectories might help interpret this result if differences were observed.

²A Bonferroni correction was also used to allow for multiple comparison statements to be made, while assuring that an overall confidence coefficient was maintained.

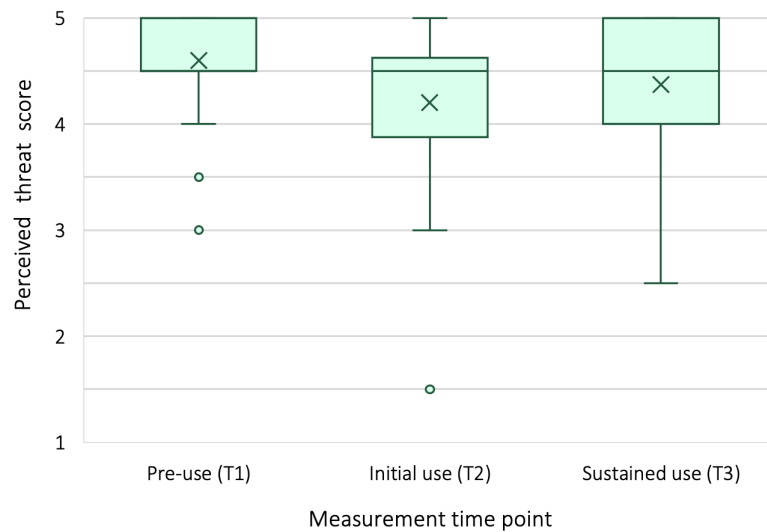


Figure 6.12: Acceptance scores for the *perceived threat* mediator, at *pre-use*, *initial use*, and *sustained use*. Mean scores are represented by a 'x' and median score by a line.

Perceived Usefulness

The *perceived usefulness* mediator reflects the degree to which users believe that the system will help improve their mental health (F. Davis, 1986). Participants' *perceived usefulness* of the self-report on smartwatch was overall high throughout the measurement points. Scores ranged from 3.0 to 5.0 ($M=4.390$, $SD=.6022$) at *pre-use*, from 3.0 to 5.0 ($M=4.222$, $SD=.7183$) at *initial use*, and from 2.0 to 5.0 ($M=4.160$, $SD=.7919$) at *sustained use* (see Fig. 6.13). There was no evidence of a statistically significant difference between the scores across the three time points ($F(2, 44)=1.303$, $p=.282$).

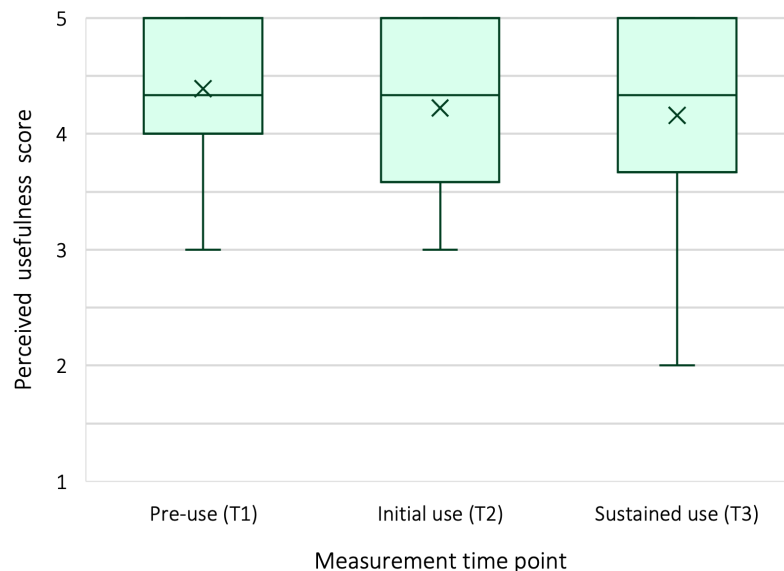


Figure 6.13: Acceptance scores for the *perceived usefulness* mediator, at *pre-use*, *initial use*, and *sustained use*. Mean scores are represented by a 'x' and median score by a line.

In the context of digital mental health, an interesting issue which emerged from discussions with clinical researchers is the potential for decreased symptoms to contribute to reduced use and *perceived usefulness* of the technology. As for the previous mediator, in cases where a significant change in these measures is noticed,

researchers interpreting this data might thus find value in also examining patients' clinical trajectories.

Perceived Ease of Use

The *perceived ease of use* mediator indicates the degree to which users believe that using a system will be free of physical and mental effort (F. Davis, 1986). Findings reveal that participants rated self-report on smartwatch as easy to use across the measurement points. Scores ranged from 3.0 to 5.0 ($M=4.293$, $SD=.6227$) at *pre-use*, from 3.3 to 5.0 ($M=4.333$, $SD=.5545$) at *initial use*, and from 3.0 to 5.0 ($M=4.407$, $SD=.6169$) at *sustained use* (see Fig. 6.14). There was no evidence of a statistically significant difference between the scores across the three time points ($F(2, 44)=.240$, $p=.787$). Observing a significant improvement in *perceived ease of use* over time could be the marker of a learning curve in the use of technology; researchers in that case might find value in examining additional acceptance antecedents, such as *computer self-efficacy* (Taylor & Todd, 1995; Venkatesh, 2000; Venkatesh & Bala, 2008; Kim & Park, 2012; Dou et al., 2017).

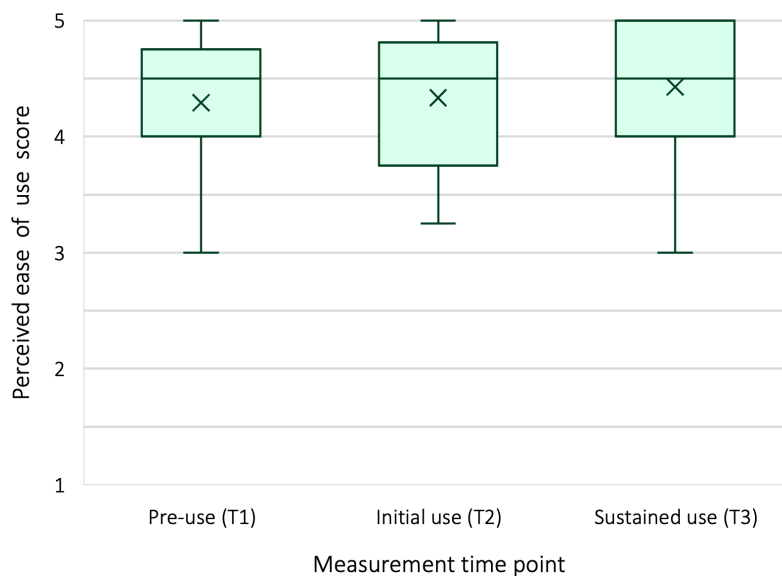


Figure 6.14: Acceptance scores for the *perceived ease of use* mediator, at *pre-use*, *initial use*, and *sustained use*. Mean scores are represented by a 'x' and median score by a line.

Attitude

The *attitude* mediator reflects the user's overall affective reaction to using a technology (Venkatesh et al., 2003). The data show that users' *attitude* toward use of the self-report on smartwatch remained high over time. Scores ranged from 3.0 to 5.0 ($M=4.700$, $SD=.5402$) at *pre-use*, from 3.3 to 5.0 ($M=4.708$, $SD=.4738$) at *initial use*, and from 3.3 to 5.0 ($M=4.630$, $SD=.5606$) at *sustained use* (see Fig. 6.15). There was no evidence of a statistically significant difference between the scores across the three time points ($F(2, 44)=.195$, $p=.824$). While patients' affective reaction to technology remained positive in our case study, changes in *attitude* should be investigated as they can signify that users are not comfortable with aspects of the technology (e.g. sharing of personal information).

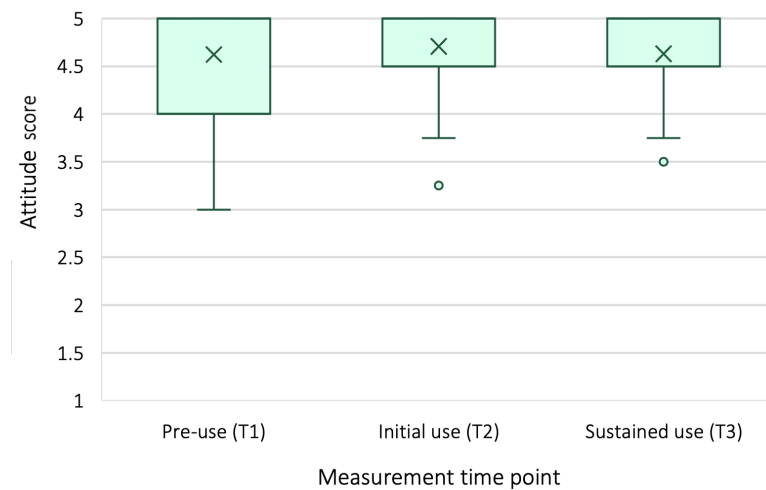


Figure 6.15: Acceptance scores for the *attitude* mediator, at *pre-use*, *initial use*, and *sustained use*. Mean scores are represented by a 'x' and median score by a line.

Behavioural Intention

The *behavioural intention* mediator represents the degree to which individuals are willing to try in order to use a technology (Ajzen, 1985). Despite a slight decrease in the participants' *behavioural intention* to self-monitor on smartwatch, the measure remained high throughout the intervention. The null spread at *pre-use* reveals patients' strong willingness to take up the technology. Scores ranged from 4.0 to 5.0 ($M=4.829$, $SD=.3824$) at *pre-use*, from 3.0 to 5.0 ($M=4.633$, $SD=.6149$) at *initial use*, and from 1.5 to 5.0 ($M=4.352$, $SD=1.0078$) at *sustained use* (see Fig. 6.16). There was no evidence of a statistically significant difference between the scores across the three time points ($F(2, 44)=.633$, $p=.536$). Similarly as with *perceived usefulness*, a significant change in *behavioural intention* to use the technology could be the result of an improvement/worsening in clinical symptoms. Moreover, such change might also be induced by users' satisfaction (or lack of) with the system. Thus, examining clinical trajectories and user satisfaction might help interpreting a change in individuals' *behavioural intention*.

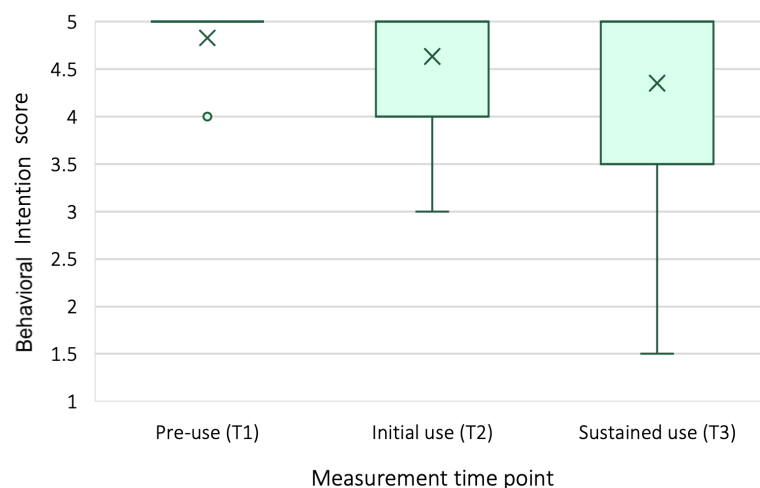


Figure 6.16: Acceptance scores for the *behavioural intention* mediator, at *pre-use*, *initial use*, and *sustained use*. Mean scores are represented by a 'x' and median score by a line.

Usage Behaviour

The study of acceptance aims to predict *usage behaviour*. The next step is therefore to examine participants' use of the technology, in order to see whether the level of acceptance measured by the questionnaire is consistent (or not) with usage. We first consider participants' use of mood self-monitoring; this revealed that the large majority of participants (30 out of 35) engaged with mood recording on smartwatch (see Fig. 6.17).

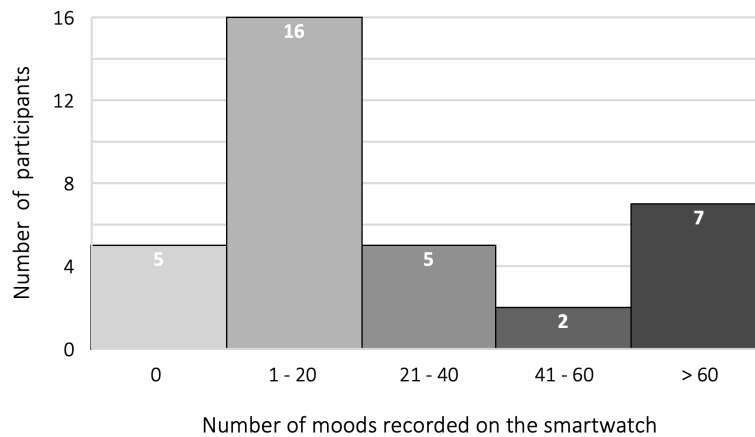


Figure 6.17: Distribution of the moods recorded via the smartwatch app.

The number of moods recorded on smartwatch ranged from 0 to 218 ($M=29.91$, $SD=45.643$). In the group of 30 participants who did use the mood monitoring, we observe differences in usage behaviour, ranging from sporadic use of mood logging in half the group, to more consistent use in the other half (e.g. 7 participants recorded over 60 moods, indicating that they engaged with self-report several times a day).

In comparison, the number of moods logged on the desktop/mobile app desktop ($M=4.31$, $SD=4.831$) ranged from 0 to 17 (see Fig. 6.18). The data was non-normally distributed, therefore, we used a Mann-Whitney test to assess for differences between mood recording on the two platforms. There was evidence of a statistically significant difference between the number of moods logged on the smartwatch vs. on the desktop/mobile app ($U=1738.000$, $p=.021$), showing patients' strong preference for recording their mood on smartwatch.

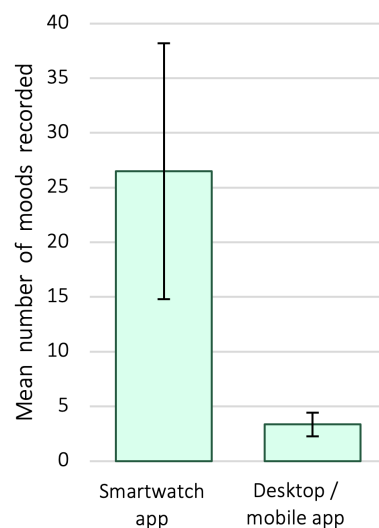


Figure 6.18: Mean number of moods recorded by platform (Smartwatch group), with error bars.

These findings indicate that the high levels of acceptance captured by the Acceptance Questionnaire scores translated into actual use of mood logging on smartwatch for most patients. Among the five participants that did not engage with the mood monitoring on smartwatch, only one completed the three acceptance questionnaires, and none participated in the post-study interview. Analysis of the non-use of the smartwatch intervention is therefore not straightforward, and the result is open to multiple interpretations (e.g. difficulty to engage with treatment, or with its online delivery, technical difficulties, non-receipt of the watch, etc.). Although knowing the reasons behind this lack of engagement would help identify additional barriers to user acceptance of self-report on smartwatch, the context of digital mental health interventions requires caution as to the demands put on patients for research purposes. Reasons behind the non-use of technology might also fall outside of what can be addressed through design. Therefore, we suggest a sensible consideration of these factors when designing acceptance studies.

Finally, we looked at patients' use of the psycho-educational 'Tips to Stay Well' feature – psycho-educational addition delivered through the Mood Monitor smartwatch app. Findings reveal that two thirds of participants in the Smartwatch group never accessed the feature (see Fig. 6.19). Among the third of participants who did access the Tips, the majority (n=8) only used the feature once, while a few patients (n=3) looked at the Tips on numerous occasions (ranging from 3 to 10 times) throughout the 8-week period. While the 'Tips to Stay Well' feature constitutes an add-on to the self-report intervention, the observed differences in usage raise the question of the value of examining user acceptance of auxiliary features.

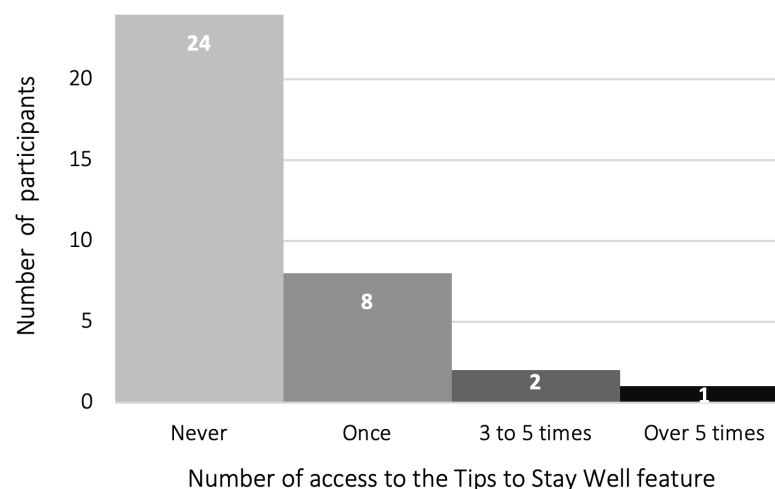


Figure 6.19: Number of times participants in the Smartwatch group accessed the 'Tips to Stay Well' feature in the smartwatch app.

6.3.4 Patient Satisfaction & *Sustained Use Acceptance*

Satisfaction has been examined as a factor of user acceptance in previous works (Schlosser et al., 2017; McManama O'Brien et al., 2017; Brittain et al., 2018; Eisenhauer et al., 2017; Niendam et al., 2018). We explore here possible associations between patient satisfaction and *sustained use acceptance* of self-report on smartwatch. Along with the final Acceptance Questionnaire at 8 weeks (T3), participants in the Smartwatch group answered the Satisfaction with Treatment measure (n=27), a Likert-scale questionnaire (four 5-item and

one 4-item). The satisfaction scores were calculated and translated into percentages. The scores ranged from 50 to 100% ($M=80.56$, $SD=15.590$), and were non-normally distributed (see Fig. 6.20). A Pearson correlation coefficient was computed to assess the relationship between the Smartwatch group participants' acceptance score at *sustained use*, and their satisfaction with treatment. The positive statistically significant correlation between the two variables ($r=.514$, $p=.006$)³ showed a strong association between long-term acceptance and patient satisfaction with treatment. This result suggests that user acceptance of the specific component that is self-report is associated with users' experience of the broader interventional context of the iCBT treatment.

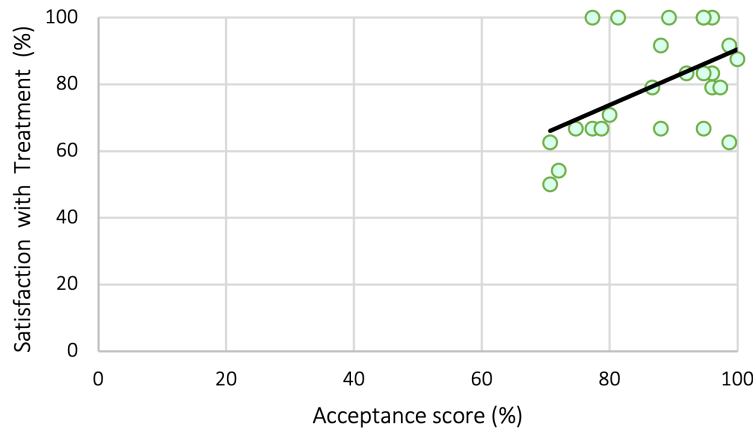


Figure 6.20: Satisfaction with Treatment questionnaire scores versus *sustained use acceptance* scores (T3).

To conclude, analysis of this quantitative data provided useful insight into (i) the overall evolution of patient acceptance over time, (ii) participants' profile and how it influenced (or not) their acceptance of technology, (iii) over-time change (or consistency) of the different acceptance mediators, and (iv) association between patient acceptance and their satisfaction with treatment. However, this information alone does not suffice to inform design of the self-report on smartwatch. To achieve this, specific facilitators and barriers to user acceptance need to be identified.

6.4 Identifying Facilitators & Barriers to Acceptance at *Pre-Use*, *Initial Use*, and *Sustained Use*

Qualitative data obtained from patients' answers to the open-ended questions in the Acceptance Questionnaires and interviews enabled the identification of facilitators and barriers to their acceptance of the Mood Monitor app across the user journey. This section details each of the facilitators and barriers at the three stages of acceptance, describing the mechanisms through which user acceptance of self-report on smartwatch was influenced.

We begin by giving an overview of the facilitators (elements that supported use of the smartwatch app) in Table 6.3, and the barriers (elements that negatively impacted use of the app) in Table 6.4.

³The significance level was .01.

Table 6.3: Facilitators of technology acceptance experienced by patients at the different stages of the user journey.

Overarching themes	Themes	Pre-use	Initial use	Sustained use
Perceived threat	I want to get better	X		
Perceived usefulness	It helps me check in with myself	X	X	X
	It encourages me to adopt healthier habits	X	X	X
Perceived ease of use	Self-monitoring is easy and convenient	X	X	X
	The smartwatch app is part of my routine	X		X
Attitude	I am familiar with smartwatches	X		
	I don't fear the judgement of others			X
	The therapy is better tailored to my needs			X

Table 6.4: Barriers to technology acceptance experienced by patients at the different stages of the user journey.

Overarching themes	Themes	Pre-use	Initial use	Sustained use
Perceived usefulness	The app doesn't allow for enough personalisation		X	X
Perceived ease of use	I don't think I can use the smartwatch	X	X	
	The app doesn't behave reliably		X	X
	It disrupts my routine			X
Attitude	I find it difficult to change my habits		X	
	I am concerned about sharing my self-report data			X

We summarised and organised these facilitators and barriers under the acceptance mediators of the HI-TAM (Kim & Park, 2012) they related to, and annotated at which stage in the user acceptance journey each element came up. This overview reveals that some factors present before use ceased to be relevant later on, while others maintained a strong influence throughout the user journey, supporting the use of a longitudinal exploration approach. To maintain anonymity of the data, we refer to each participant in the Smartwatch group by an ID (e.g. SW1).

6.4.1 Pre-Use Acceptability Facilitators

Patients' motivations for the uptake of the Mood Monitor included a desire to improve their mental health, the belief that the watch app would be an efficient means to self-monitor, support the adoption of healthier behaviours and reduce their burden, and familiarity with smartwatches.

I Want to Get Better

Participants shared their **concerns about their mental health status**, a powerful motivation for the uptake of the technology: *"I am open to all ways to help my mood improve"* (SW28). Patients' willingness to *"try anything to help myself feel better"* (SW19) spoke of the hopelessness experienced when seeking help for mental health difficulties: *"I would like to give it a try as I have tried everything with my best abilities and I am scared when it [depression] is going to strike me again"* (SW7).

It Helps Me Check in with Myself

The perceived efficiency of self-report on smartwatch was also a significant determinant of patient acceptability, with participants mentioning how the smartwatch could enhance self-report activity. Firstly, self-report on the watch was perceived as a way to **support consistent monitoring** of mood and lifestyle habits: *“It will enforce me to keep a record of my mood & exercise”* (SW1). Secondly, patients mentioned that they felt this approach could help them *“better gauge my mood”* (SW5) and *“keep a regular check on my moods”* (SW9), therefore supporting an **increased self-awareness**. The duality of **tracking mood and lifestyle habits** was seen as particularly helpful to monitor both *“my mental and physical well being”* (SW7). Particularly, patients were hoping to gain insight into sleep patterns as *“this is something I am struggling with at the moment”* (SW26).

It Encourages Me to Adopt Healthier Habits

Several patients mentioned that they would use self-report data to **recognise mood patterns**, and for example *“know how often [I] feel low and track what I do to stop feeling low”* (SW24). Specifically, they wrote about wanting to identify lifestyle habits influencing their mood, to *“get a better understanding on situations that [are] contributing to depression with stuff like sleep deprivation and activity levels”* (SW27).

The use of the wearable device itself was seen as a good way to **motivate behavioural change**: *“I believe a smartwatch would encourage me to consistently exercise”* (SW4). Finally, one patient evoked that being able to share the data recorded on watch app might **inform the clinician regarding their progress** — *“at times when I can’t see them through the app”* (SW6) — potentially giving them more information to provide feedback on.

Self-Monitoring is Easy and Convenient

Being ‘better’ than paper-based self-report was a motivation to take on technology for some patients, for reasons including a **greater ease of use** (SW20, SW25) and a **higher convenience** — *“can be used anywhere at any time”* (SW6). The Ecological Momentary Assessment was also seen as a contributor to **reducing the demands** placed on patients, such as *“recording things on paper or trying to remember [past events]”* (SW8).

I am Familiar with Smartwatches

Seeking a seamless integration of technology into their daily life, patients mentioned owning a smartwatch and health monitoring apps as incentives to use self-report on smartwatch: *“I use my Apple Watch daily ... I don’t feel that this will be difficult to implement into my routine.”* (SW23).

Familiarity with the smartwatch technology also triggered a certain enthusiasm in participants — *“I already own an Apple smart watch & enjoy using it for exercise”* (SW16) — sometimes mixed with curiosity: *“I have found it [my Apple watch] useful before in tracking sleep and steps etc. However, I have never used it to track mood”* (SW34). Therefore, a **smooth integration of the technology** 1) within the patient’s daily routine,

and 2) within their technological habits, strongly contributed to uptake.

6.4.2 *Pre-Use Acceptability Barriers*

Eligible patients who were offered the study and refused to take part were asked if they wanted to explain their choice. Thirteen gave their verbal consent to the clinician, and provided a reason for declining — helping to identify anxiety towards using the smartwatch as a barrier to patient acceptability.

I Don't Think I Can Use the Smartwatch

The smartwatch technology raised concerns in some patients, regarding their **ability to use the device**: “*I don't think that I am the best for something like that as I'm not good with technology*” (Anonymous). The use of the device also raised concerns in one patient, **worried about discomfort** as they found wearing watches irritating to the skin.

6.4.3 *Initial Use Acceptance Facilitators*

At *initial use* stage, participants discussed how the efficient approach to self-report and the diminution of their burden enabled by the Mood Monitor facilitated their acceptance of the watch app.

It Helps Me Check in with Myself

The most discussed facilitating element at *initial use* was patient *perceived usefulness* of self-report: “*it's helpful to record the moods*” (SW9) and “*I have found its helped me keep track of things better*” (SW31). Particularly, several participants praised the reminders which **supported consistent monitoring**, explaining how they “*remember to log my mood data when it [the watch] notifies me*” (SW23) and how they saw their engagement with self-report improved (SW21). Another mentioned recurrent benefit was how wearing the smartwatch was “*very useful for monitoring exercise*” (SW12), and **motivated behavioural change**: “*Wearing watch itself really makes me walk more and get fresh air*” (SW29).

By monitoring their mood and lifestyle habits with the watch app, patients reported an **increased self-awareness**, as the mood prompts were “*a good reminder to focus on myself & my feelings throughout the day*” (SW16), and the automated tracking of sleep helped them gain insight into pre-existing issues: “*its also interesting to me the data it gathers on my sleep as I know I don't sleep much*” (SW31).

Self-Monitoring is Easy and Convenient

Participants' remarks at *pre-use* stage, highlighting the importance of a self-report approach that diminished their burden, found an echo at *initial use*. The perceived **ease of use** of the app was mentioned multiple times, and particularly the quick interactions enabled by the smartwatch technology and how they supported patient engagement: “*I do think that it is quicker and easier to log my mood on the watch*” (SW1).

Finally, self-report via a wearable device was once again evoked as a **convenient support for ecological momentary assessment**: “*It’s handy having the app on your person, so to speak, so you can log your mood easily*” (SW33).

6.4.4 *Initial Use Acceptance Barriers*

At this stage, participants discussed obstacles to their acceptance, including the unreliable behaviour of the app, anxiety towards using the smartwatch, the need to change personal habits, and the desire for more tailoring to their needs.

The App Doesn’t Behave Reliably

Usability issues in the Mood Monitor app causing the system to malfunction was the most frequently mentioned obstacle to use. Patients’ responses mentioned how the **inconsistent behaviour of the app** did not match their expectations: “*Some days it hasn’t asked me for the mood*” (SW21), sometimes forcing them to take actions to solve the issue: “*I have to uninstall the watch app and reinstall it to get it working again*” (SW23).

Some participants were reassured seeing that, despite some inconsistencies in the behaviour of the watch app, it was “*still record[ing] my sleep, activity and mood etc.*” (SW36), while for others, not knowing if the data was correctly recorded became a **source of self-doubt**, induced by the impression that one is not using the system as it was intended: “*I am not sure if I am using the app correctly*” (SW4).

I Don’t Think I Can Use the Smartwatch

Frustration could also be felt in SW7’s response to the second AQ. However, despite their struggles with smartphones, the patient was willing to give the smartwatch a try: “*I don’t have laptop and only using this annoying small screen iphone ... Don’t know how to make it [the smartwatch] work as I struggled with technology, but willing to learn*”. This statement highlights that even strong barriers to acceptance might not stop one from using the technology, if stronger motivations exist.

I Find it Difficult to Change my Habits

By the time they received the study smartwatch in their post, some participants had already taken the habit to self-report their mood on the mobile app. Difficulty in changing one’s habits resulted in a delay in the uptake of the watch app, for example for SW28: “*Didn’t use it straight away as I was recording the mood data on my smartphone*”.

Another patient’s comment reflected the **impact of depression symptoms on one’s ability to change**: “*some days, I just don’t put it on as I am just being lazy etc*” (SW30). The language employed by SW30 (i.e. ‘just being lazy’) is recurrent in the responses of people experiencing depression speaking of a misinterpretation of

depression symptoms for laziness (Morey-Nase et al., 2019), or the judgement of their peers/relatives (Scharp & Thomas, 2017), often leading to an **attitude of self-blame** (Maija & Katri, 2019).

Finally, **physical discomfort** induced by the wearable impeded the continuous collection of sleep data. Although wearing the watch at night was optional, some patients did so, hoping that it could provide a more accurate reading of sleep patterns. However, keeping the watch on overnight was sometimes source of discomfort: *“I find it quite uncomfortable always sleeping with the watch on”* (SW9).

The App Doesn’t Allow for Enough Personalisation

Several comments concerned the list of lifestyle elements presented after a user logged a mood: *“the options it gives me I don’t think are the reasons affecting my mood”* (SW1). Adding *“more causes of moods ie stress, finances etc.”* (SW9) or *“your own reasons for why you feel that way sometimes other than what is on the app”* (SW20) were mentioned as solutions to **better tailor the app** to patients’ needs.

6.4.5 Sustained Use Acceptance Facilitators

Patients’ answers to the final AQ (T3) and post-study interviews revealed that, while most of the acceptance facilitators identified at pre or initial use persisted at *sustained use*, a range of additional factors came into play, including a seamless integration of the technology, no stigma associated with use, and a therapy further tailored to patients’ needs.

It Helps Me Check in with Myself

At *sustained use* again, the most mentioned benefit of the watch app was that it **encouraged consistent mood monitoring**, particularly through the mood reminders: *“every time I was prompted, I would log my mood”* (SW5) and *“the reminders really helped otherwise I would have definitely forgot”* (SW36). Delivering self-report on smartwatch also supported patient compliance: *“I stopped logging my mood since I haven’t had the watch”* (SW33). In addition, participants highlighted how the reminders also helped *“create a routine”* (SW28), *“to stop and check in with how you feel”* (SW9).

Being able to check in with oneself helped patients **gain self-awareness**, making them *“more aware of yourself, how you are physically and emotionally”* (SW5). Because *“we don’t always pay attention to our mood so closely”* (SW36), identifying one’s current mood can be challenging, as reflected in SW14’s interview:

« When I got the reminder in the morning, I wasn’t sure how I was feeling. So when it asked me to record my mood, I actually took 2 min to understand how I’m feeling... I would carry one problem or another... But now, if I know that I’m in a bad mood, I know that I have to lay low, just let it pass and it’s going to be okay. »

With a similar experience, other participants mentioned how receiving the mood reminders on the watch itself *“broke the cycle ... especially when I’m feeling anxious”* (SW5) and helped **train their self-awareness**:

“train myself to stop and think about my mood” (SW29).

Finally, some patients pointed out the difficulty to *“stop, take time, log the information and do it there and then” (SW17)* and the need for retrospective reflection: *“[the watch app] allowed me to make a note of effectively how I was feeling at that point in time, and then go back and retrospectively look at it” (SW17).*

It Encourages Me to Adopt Healthier Habits

Regarding the *pre-use* motivation for the uptake of the app, participants commented on how the Mood Monitor supported behavioural change. First, the **identification of patterns** between mood and lifestyle habits was made easier (SW26), helping patients understand *“why I was feeling that way, what had changed for me to be like this” (SW5).*

Reflection was further encouraged by the app asking patients which elements might have affected their mood: *“you have to give a reason [for your mood], it does make you more self-aware of the likely reason you are feeling good or bad” (SW34).* Particularly, the impact of sleep and physical activity was rendered more explicit: *“When I wasn’t getting enough sleep or if I was having too much sleep, I did actually notice that it was making me feel a bit grouchy or irritable the next day, and that’s something I never kind of linked together” (SW36).*

The increased self-awareness of patterns **supported behavioural change** in participants, enabling them to adopt healthier habits: *“before I’d be like ‘oh I don’t want to go do that, what’s the point’ but actually doing it did make a difference ... being more active or getting out and doing more things, then it actually made my mood a bit better sometimes I think” (SW36).* Finding the motivation to engage in physical activity is often challenging for individuals experiencing depression (Busch et al., 2016), participants described how seeing their step count in the app gave them a ‘boost’ (SW5) to get active: *“It motivated me to go for walks more ... I don’t think I would have really been motivated to do that if I hadn’t had the smartwatch” (SW5).* The Apple Watch daily prompts to stand up and encouragements to set and reach fitness goals acted as an additional motivation: *“[the watch] encouraged me to get out of bed and try and get active” (SW11).*

Similarly, the Apple Watch bedtime reminder and wake alarm — which participants were instructed to set up to enable sleep tracking — helped them maintain a sleep routine, particularly the bedtime reminders which acted as *“a cutoff point ... otherwise you can blink and it will be 10:30. So yeah, I did find it helpful in keeping a routine” (SW34).*

Self-Monitoring is Easy and Convenient

The use of smartwatch was praised by participants as a **convenient delivery means** for the mood self-report, making it *“easier to record them [moods] there and then” (SW1).* SW5, for example did *“all my mood logging on the watch”*, while SW28 commented *“It’s more convenient than remembering to write it down or having to go online to do it”.*

The convenience of the mood self-report on the watch supported patient engagement with self-report, logging their mood *“more frequently than I necessarily would have on the computer” (SW33).* Particularly,

mood logging on the smartwatch was described as **quick and effortless**, compared to via the mobile and desktop app for the intervention which required an ‘extra effort’ (SW34, SW17): *“it was a lot easier to do it on a smartwatch app because it’s not like everyday I’m going to want to log into SilverCloud [platform]”* (SW36).

The location and proximity of the smartwatch, **allowing immediate interaction**, further facilitated self-report: *“it’s there, and you’re not having to pick up your phone from somewhere else”* (SW34). Finally, some participants mentioned a lessened burden associated with the tracking of sleep: *“trouble sleeping was much easier to track”* (SW26).

I Don’t Fear the Judgment of Others

Stigma associated with mental health difficulties was a source of worry for most participants, with some hiding their ongoing treatment: *“it’s not something that I’d like to advertise to everybody”* (SW17). Engaging with the Mood Monitor watch app felt safe for participants, as it did not make their difficulties visible to others. Through their ‘subtle’ interface, the reminders enabled a **discreet logging of the mood**: *“if somebody saw it on my watch, they wouldn’t realise I was involved in something like this programme”* (SW17). The smartwatch itself was described as a **more private means to self-report**, *“almost under the radar. ... sometimes if you’re on a big phone, you know, people can see more. If it’s just on your watch, nobody’s really interested.”* (SW34). Most patients also declared feeling comfortable when logging their mood in a social context:

« We were out with friends this past weekend, and I got some reminders, and I felt very comfortable just kind of quietly logging it, and just taking a second to check in with myself. » SW5

For participants who were open to their relatives about undergoing treatment, the Apple Watch acted as a conversation starter (SW33). The interest sparked by the smartwatch **created opportunities to speak about the programme**, which felt empowering for some patients, for example SW29 who was *“trying to make it quite casual, and I’d say ‘oh I’m just enjoying this programme, it’s really good and then it actually allowed me to use Apple Watch for 6 weeks’. So, I’m sort of telling people in a way that if you ever need help, there’s a way for you”*.

The Therapy is Better Tailored to my Needs

Participants reported feeling **comfortable sharing the data collected** through the Mood Monitor watch app with their clinician: *“it was just the Mood Monitor, I did not mind sharing that”* (SW14). Trust in how their personal data was handled reinforced that feeling: *“I do trust them [the clinician] ... I know they won’t be discussing any of my personal information, unless they think I have a life threatening moment”* (SW29). This attitude was primarily motivated by the desire to get better: *“at the end of the day it’s in my best interest”* (SW36).

First, participants believed that **the more information the clinician has, the better they can help**. Providing information about their daily mood and lifestyle habits appeared particularly helpful to *“give them [the clinician] an idea of what I’ve been doing and how I’ve been feeling day to day”* (SW31), so that they

could “*understand how I exactly feel*” (SW29). With regard to lifestyle information, participants evoked how it could “*give a lot deeper insight for the supporter... rather than just asking me ‘how have you been sleeping?’*” (SW28). Furthermore, self-report data might provide complementary information to the clinical questionnaires, affected by recall bias and “*very subjective, you might think you’ve been feeling a different way to how you actually have been feeling... it would be quite a good comparison for them to see actually how you felt every day for 2 weeks against the questionnaires*” (SW36).

Secondly, participants trusted the clinician’s expertise to **identify pertinent elements in the data** and tailor conversations (SW29), detect warning signs (SW23), and assess clinical outcomes (SW10, SW18).

It is Part of my Routine

Lastly, participants described how self-report “*quickly **became into a habit***” (SW29), “*a part of normal life*” (SW26). Wearing the watch both integrated into their routine: “*I got into the habit of just putting it on every morning pretty much straight away*” (SW5), and with the technologies they used: “*I’ve found it quite great that it sort of seamlessly worked, it integrated with everything that you already have*” (SW33).

6.4.6 *Sustained Use Acceptance Barriers*

Answers to the final questionnaire (AQ at T3) and post-study interviews revealed that factors such as a lack of tailoring in the content of the app, an unreliable or disruptive behaviour, usability issues, and a lack of trust with regard to the handling of personal data, were obstacles to patient acceptance.

The App Doesn’t Allow for Enough Personalisation

Most patients reported that the list of options from which they could select which factor(s) influenced their mood was not relevant to their situation: “*I didn’t really find them [options] particularly relevant, so I got into a habit of just overlooking it... That definitely was something that kind of put me off using it*” (SW33).

Some participants suggested adding more reasons to explain the mood — “e.g. ‘Family/friends’, ‘Work’, more lifestyle factors as I found this greatly influenced my mood” (SW34). **Enabling customisation** of the list was also evoked: “*hav[ing] the opportunity to constantly edit it and put in your own [factors] I think would be fantastic*”.

Patients also missed being able to apply a valence to each factor, to record “*if it affected in a positive or negative way*” (SW12): “*I feel down because I haven’t done exercise, therefore, exercise is a reason. But equally, when I was logging me having a great mood after I’d gone for a nice run, then exercise was also a factor*” (SW34).

Adding an extra step to self-report (e.g. “*where you’re like [selecting] ‘too much caffeine’ [or] ‘too little caffeine’*”, SW34) was evoked as a solution. Participants also discussed how the smartwatch app could go a step further in terms of customisation, to support their engagement with self-report. The use of generic encouraging prompts (e.g. ‘Well done’) was strongly contested: “*I think the generic messages just wash over*

people because we get so many of them” (SW17). Participants suggested sending prompts “relevant to what you’ve done” to support engagement (SW17, SW36).

Such custom messages based on the self-monitoring data collected, might also support introspection and action: “If there was poor sleep going on, asking the questions ‘Is everything OK? Is there something that you need to talk somebody about?’... The more personalised, the better” (SW33). Explicitly evoking recorded data was also suggested to enhance the prompts:

« Something that was relevant to you personally, [e.g.] ‘So we’ve noticed that the last 3 days you’ve had less sleep and your mood is declining’... you could then take an action. » SW17

The App Doesn’t Behave Reliably

Some participants managed to solve technical issues by reinstalling the app: “that was just an initial hiccup, but I got over that” (SW5). However for others, the issues persisted (e.g. “I don’t think the reminders came through consistently”, SW17), negatively impacting their acceptance of the technology: “I would have used it more regularly if the reminders worked” (SW33).

I am Concerned about Sharing my Self-Report Data

Sharing lifestyle data collected through the Mood Monitor with their clinician sometimes induced worries in participants: “it just puts a little more pressure on you (SW14). When asked how their clinician should use the data collected through self-report on the watch, SW35 simply replied “With care”, reflecting the caution needed when dealing with sensitive data. Particularly, patients expressed that they did not want to ‘feel trapped’ (SW5) and **under surveillance**: “I’m not sure that I would necessarily want my clinician to be kind of Big Brother-ing on my sleeping trends” (SW5). Particularly, as much as they would like sharing data reflecting improvements, giving access to unsatisfactory data would be a cause of additional stress: “It would have been nice if she had said ‘I see that you’ve been moving more, that’s really good!’... but I wouldn’t want them to hold that against me if I haven’t been sleeping well or if I haven’t been exercising” (SW5). A comment by SW14 also highlighted the risk of sharing unsatisfactory data, which could potentially lead to self-blame: “What happens if I am not able to work out for 2 days?... they would think that I’m not working out, or I’m not doing good enough” (SW14). Pointing out the difficulty to maintain a sleep and exercise routine when experiencing depression symptoms, the participant further argued that self-report data shouldn’t be used to make them answerable for something they had little control over:

« I would want to work out some days, but my body has no energy. I can’t go and explain it to someone why I feel that way because that is how I feel... It’s okay if they have it [the data], right, but I don’t want any questions asked as to why. » SW14

Finally, **lack of trust** in the secure handling of data was an obstacle to self-monitor sleep on the watch. SW17, who owned a smart sleep mat, explains: “I chose not to share that information [sleep]... I was very concerned about having another source, another outlet which I wasn’t overly comfortable had been fully secured”.

It Disrupts my Routine

For some participants, wearing the smartwatch **disrupted their routine**. Responses revealed that the watch made switching off from technology difficult: “*I couldn’t really switch off... having it on my arm and seeing it all the time, sometimes I felt a bit drained and like I wasn’t actually connected to the real world*” (SW36).

The automatic delivery of notifications and the frequent ‘Stand up’ and ‘Breathe’ prompts of the Apple Watch was described as ‘*annoying*’ (SW6), particularly when interrupting participants in the middle of work (SW29, SW34). Once again, the importance of personalisation came up in the responses, with the suggestion of adjusting the sending of prompts (including the mood reminders, SW36) to one’s calendar: “[*the watch*] *would see that I’ve got a free spot in my calendar... It gives the watch a slot and it is more likely to get my attention when I’m not already busy*” (SW17).

6.5 Exploring Acceptance in a Multi-Arm Context

Beyond measuring patient acceptance of self-report on smartwatch throughout treatment, this case study went a step further by exploring the evaluation of user acceptance in a multi-arm setting. As the smartwatch app addition is potentially more invasive than self-report on the mobile app, there is value in investigating whether there is a significant difference in user acceptance in both groups. This additionally inform on the feasibility of the integration of the smartwatch in the iCBT programme.

6.5.1 Overall Patient Acceptance of Self-Report

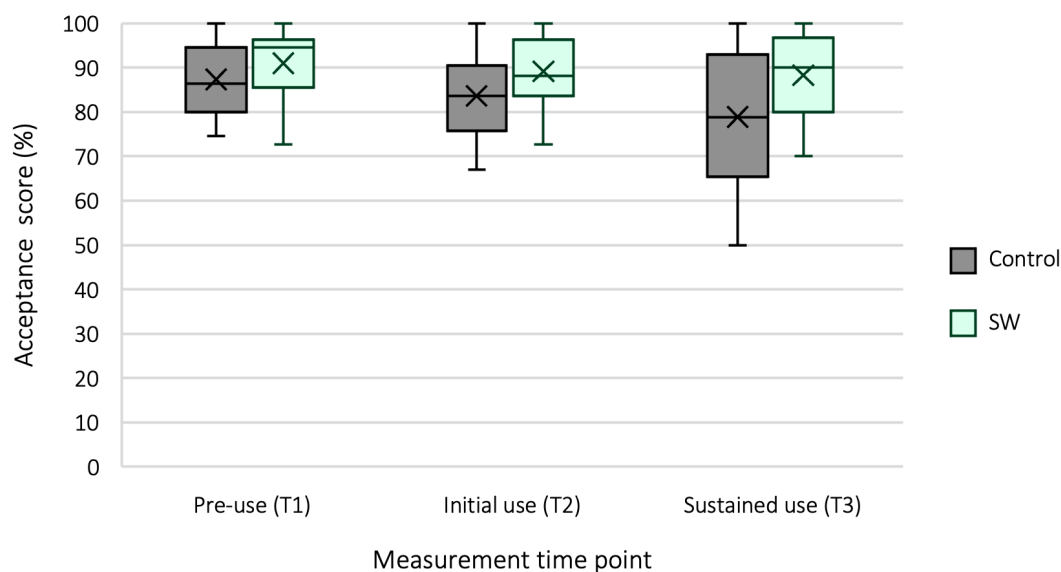


Figure 6.21: Acceptance scores per group, at *pre-use*, *initial use*, and *sustained use*. Mean scores are represented by a ‘x’ and median score by a line.

In order to understand how the introduction of the smartwatch impacted patient acceptance of the self-report component of the iCBT intervention, we compared the AQ scores obtained by both groups at *pre-use*, *initial use*, and *sustained use*. Acceptance Questionnaires for the two groups shared the same 12 questions⁴. In order to compare the acceptance scores obtained in both groups, the scores in the Smartwatch group were re-calculated to only include these 12 subset of questions. Figure 6.21 gives an overview of the evolution over time of the acceptance scores for each group. Compared to the Smartwatch group's scores which remained stable throughout treatment, the control group's scores gained in spread over time, and the mean score slightly decreases from *pre-use* (n=34, M=86.36, SD=8.001), through *initial use* (n=28, M=83.64, SD=9.924), to *sustained use* (n=32, M=78.75, SD=14.300). While this result shows that both interventions are highly accepted by patients, it is interesting to understand where the discrepancy in the evolution of the scores come from — in other words, why acceptance of the Smartwatch group remains high over time, while that of control is subject to more variability. Therefore, we next compared the mediators scores of both groups.

6.5.2 User Acceptance Mediators Scores

We compared the evolution of the mediators scores in both groups with a repeated-measures ANCOVA (which controlled for the effects of the relationship status variable). As before, a Bonferroni correction was used to allow for multiple comparison statements to be made, while assuring that an overall confidence coefficient was maintained. There was no evidence of a statistically significant difference between the scores across the three time points for the mediators *perceived threat* ($F(2, 98)=2.170$, $p=.120$), *perceived usefulness* ($F(2, 98)=1.571$, $p=.213$), *perceived ease of use* ($F(2, 98)=1.120$, $p=.330$), and *behavioural intention* ($F(2, 78)=1.543$, $p=.220$).

Attitude

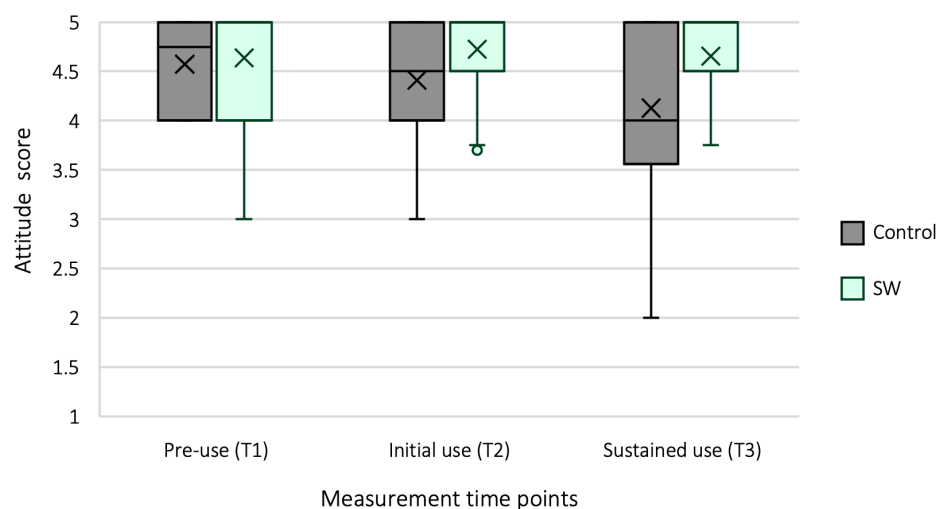


Figure 6.22: Acceptance scores for the *attitude* mediator, per group, at *pre-use*, *initial use*, and *sustained use*. Mean scores are represented by a 'x' and median score by a line.

⁴The Smartwatch group questionnaire comports an additional 3 questions.

Results showed evidence of a statistically significant difference for the mediator *attitude* ($F(2, 98)=5.176$, $p=.007$). Figure 6.22 shows that indeed, the evolution trends in the acceptance scores in both groups are opposite: in the Smartwatch group, patients' attitude scores increased over time and the spread diminished; in the control group, patients' attitude scores decreased over time and the spread increased. While we have seen, through Smartwatch participants' answers to open-ended questions and interviews, that they felt more and more comfortable logging their self-report over time, drawing conclusions as to why the control group felt less comfortable self-reporting on the desktop/mobile app would require gathering additional qualitative feedback from this group.

Usage Behaviour

We examined between-group differences in terms of mood, sleep and exercise self-reported, as to assess whether the degree of user acceptance in both groups was consistent (or not) with actual use of the technology.

Findings indicate a strong discrepancy between the number of moods recorded in the Smartwatch group, and in the control group (see Fig. 6.23). The data was non-normally distributed, therefore a Mann-Whitney test was used. There was evidence of a strong statistically significant difference in the number of moods recorded between groups ($U=245.0$, $p=.000$). Indeed, participants in the Smartwatch group ($M=15.61$, $SD=20.185$) logged considerably more moods than the control group ($M=5.38$, $SD=6.036$), showing a greater compliance with self-report.

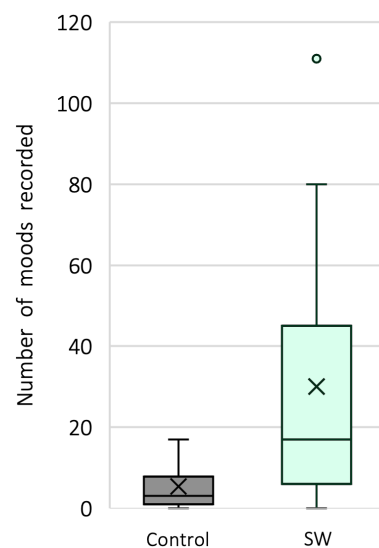


Figure 6.23: Number of moods recorded in both groups. Mean scores are represented by a 'x' and median score by a line.

This finding support patients' qualitative answers previously analysed, highlighting the positive impact of the smartwatch app reminders and the wearable nature of the watch on patient engagement with mood monitoring.

When recording their mood, participants were asked to select a rating from 1 (very low mood) to 5 (very good mood), conveying the valence of the mood. A Mann-Whitney test showed no significant difference

($U=143808.0$, $p=.575$) in the rating of the moods recorded in the Smartwatch group ($M=2.95$, $n=1176$) and in the control group ($M=3.03$, $n=250$). This finding highlights that the patients in this study tended to self-report their mood regardless of how they were feeling (see Fig. 6.24).

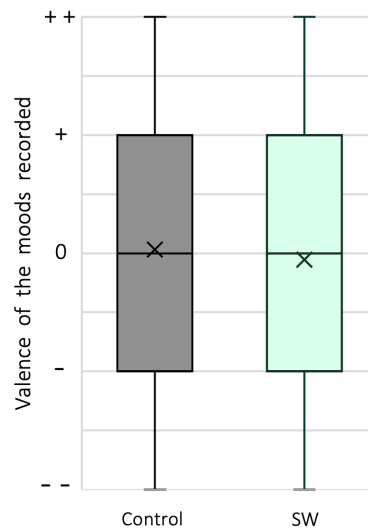


Figure 6.24: Valence of the moods recorded by participant, in both groups. Mean scores are represented by a 'x' and median score by a line.

Findings also suggest that the use of the smartwatch app positively impacted patient self-monitoring of sleep and exercise. First, we observed a considerable gap between groups in the number of participants who used the sleep and physical activity tracking. On one hand, 23 (out of 35) participants in the Smartwatch group used the sleep recording against 14 (out of 34) in the control group (see Fig. 6.25).

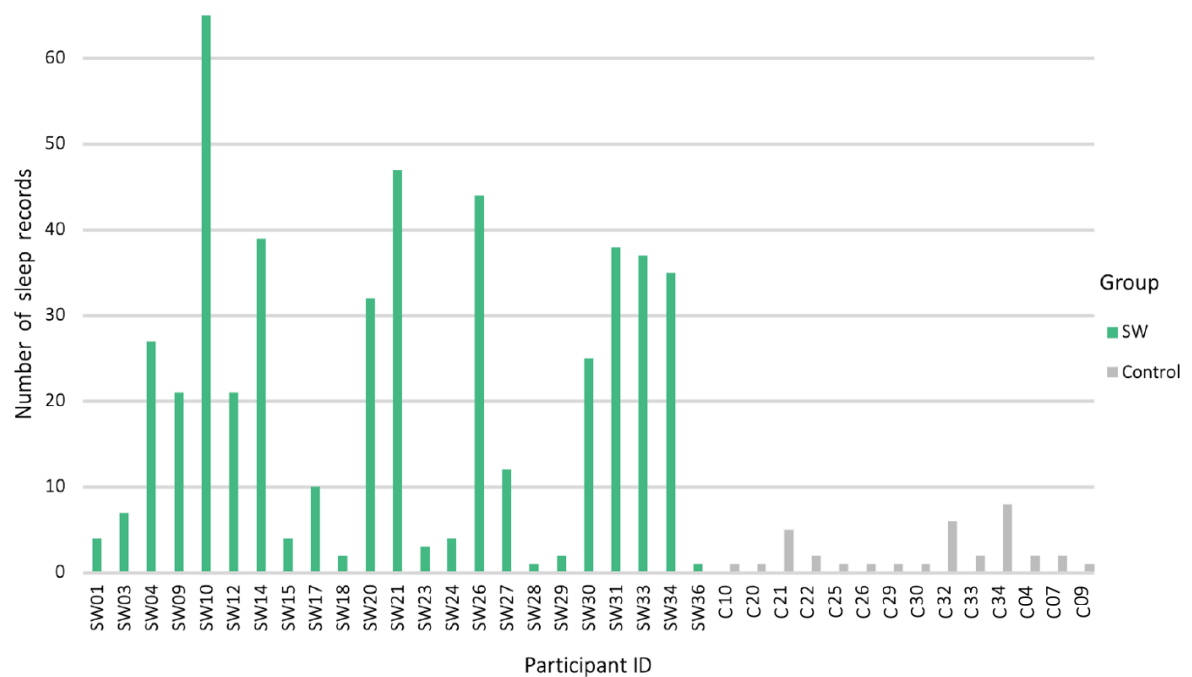


Figure 6.25: Sleep records by participant, in both groups.

On the other hand, 29 (out of 35) participants in the Smartwatch group used the exercise recording against only 3 (out of 34) in the control group (see Fig. 6.26).

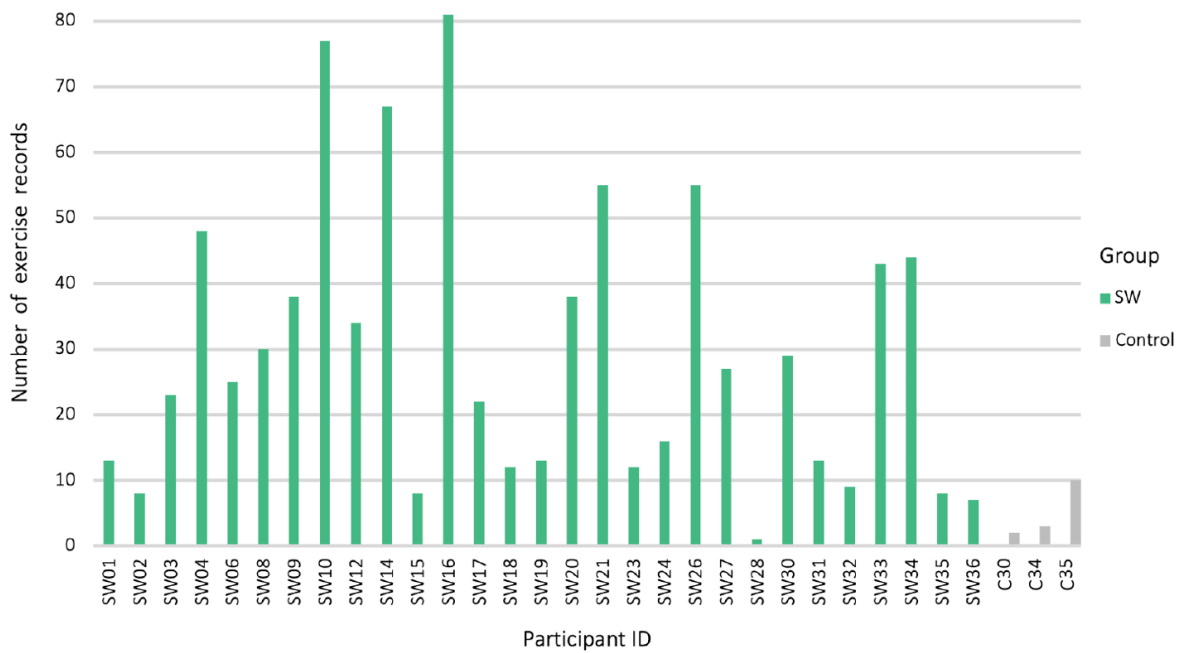


Figure 6.26: Exercise records by participant, in both groups.

Second, findings reveal a substantial gap in the number of records collected. Looking at the sleep data first, the number of sleep records ranged from 0 to 65 in the Smartwatch group ($M=13.74$, $SD=17.937$), and from 0 to 8 ($M=1.0$, $SD=1.859$) in the control group (see Fig. 6.27a). Considering then the exercise data, the number of exercise records ranged from 0 to 81 in the Smartwatch group ($M=24.46$, $SD=22.822$), and from 0 to 10 ($M=.44$, $SD=1.795$) in the control group (see Fig. 6.27b).

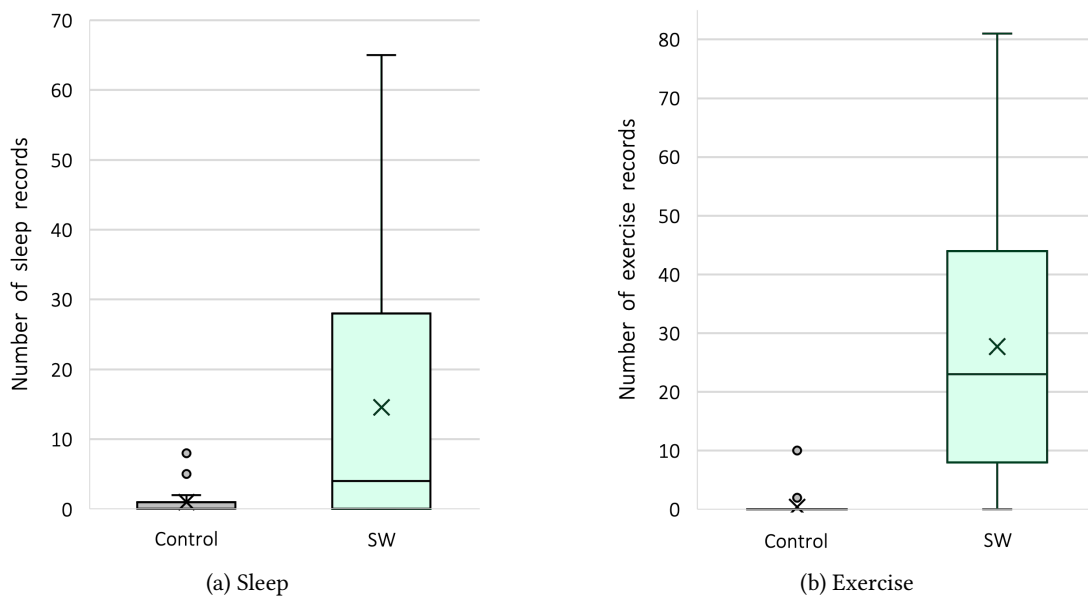


Figure 6.27: Differences in engagement with the monitoring of lifestyle habits. Mean scores are represented by a 'x' and median score by a line.

The data being non-normally distributed, Mann-Whitney tests were employed to assess the nature of the difference in the number of records. There was evidence of a strong statistically significant difference in the number of sleep records between the Smartwatch ($n=477$) and the control ($n=36$) groups ($U=308.0$, $p=.000$).

There was also a strong statistically significant difference in the number of exercise records between the Smartwatch (n=896) and the control (n=14) groups ($U=82.0$, $p=.000$). This supports the finding that self-report of sleep and physical activity was substantially more complete when automated (i.e. with the smartwatch), than when manual (i.e. with the desktop/mobile app).

Looking more closely at the data of the Smartwatch group, we notice a trend in the use of self-report of sleep and exercise, with the majority of participants (about 60%) logging between 1 and 40 records (see Fig. 6.28 and 6.29).

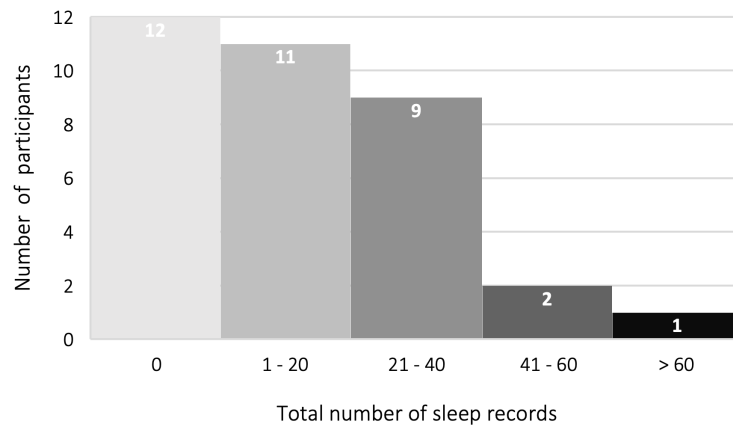


Figure 6.28: Sleep records by participant (Smartwatch group).

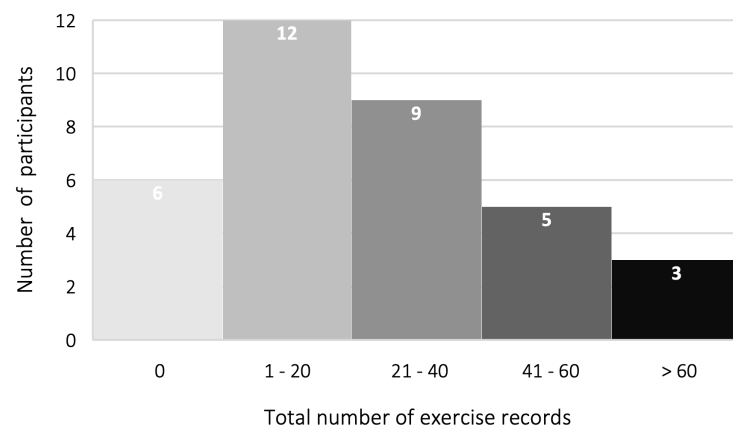


Figure 6.29: Exercise records by participant (Smartwatch group).

Yet, a slightly higher number of participants used the tracking of exercise (n=29) in comparison to the tracking of sleep (n=23). Particularly, a third of the group (n=12) did not log any sleep records. This could indicate a lower level of acceptance of the collection and sharing of sleep data in this subset of patients. However, the acceptance scores at *sustained use* (T3) reveal that these participants all reported a high degree of acceptance, with scores ranging from 70 to 100 ($M=89.79$, $SD=10.890$). Because instructions needed to be followed to enable sleep monitoring on Apple watch, we hypothesise that this absence of sleep records might be due to issues enabling sleep monitoring.

Finally, we looked at the *values* recorded for sleep (i.e. number of sleep hours) and exercise (i.e. level of activity). The programme allowed users to log a number of sleep hours slept between <1 and 15, and a level of activity between 1 (not active) to 5 (very active). Findings show that the number of hours slept recorded by participants ranged from 1 to 15 in the Smartwatch group ($M=6.11$, $SD=2.339$), and from 0 to 10 in the control group ($M=6.58$, $SD=1.713$). The activity level recorded ranged from 1 to 5 in the Smartwatch group ($M=2.84$, $SD=1.335$), and from 2 to 5 in the control group ($M=3.86$, $SD=1.099$). The data being non-normally distributed, we assessed for significant differences with Mann-Whitney tests. The first test revealed no evidence of a statistically significant difference in the average number of sleep hours recorded. However, the second test showed evidence of a statistically significant difference in the average level of activity recorded ($U=4501.0$, $p=.024$). Indeed, participants in the control group tended to manually record exercise on active days, while the automated self-report in the Smartwatch group captured both active and less active days (see Fig. 6.30), therefore painting a more accurate picture of the patients' exercise habits.

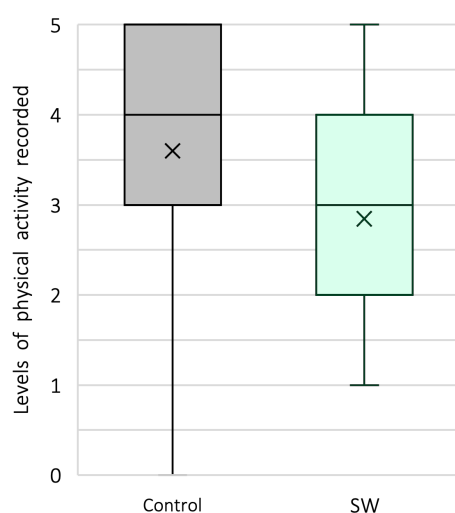


Figure 6.30: Intensity of the physical activity recorded through self-report in both groups. Mean scores are represented by a 'x' and median score by a line.

To conclude this analysis, acceptance questionnaires are intended to predict usage behaviour. Yet, high levels of acceptance don't necessarily translate into usage. In the case of the Smartwatch group, the Acceptance Questionnaire scores were consistent with patients' actual use of mood logging on smartwatch. However, this was not the case for the control group, which despite a high level of acceptance struggled to engage with self-report. We argue that, while the overall acceptance scores give an indication of patient acceptance, it is not sufficient to draw conclusions about future usage of the technology. This supports the need for analysing qualitative data at the three time points, to provide a finer-grained understanding of patient acceptance of the technology, and the reasons why it does translate into usage for the Smartwatch group.

6.6 Assessing Feasibility

We considered the potential influence of using the smartwatch app on patient use of the iCBT intervention.

Use of the iCBT Programme

First, we looked at metrics on the usage of the programme, including (i) the total time on the platform, (ii) number of sessions, (iii) number of tools used, (iv) percentage of the programme viewed, and (v) the number of reviews. Descriptive statistics on these metrics, per intervention group, can be found in Table 6.5.

Table 6.5: Descriptive statistics on the programme usage metrics, per group.

Metrics	Group	Mean	SD
Total time on platform (s)	Control	11637.63	9452.991
	SW	9663.09	7046.912
Number of sessions	Control	15.50	11.769
	SW	18.54	10.279
Number of tools used	Control	6.25	3.592
	SW	6.20	3.612
Percentage of the programme viewed	Control	48.24	29.9229
	SW	52.94	31.0091
Number of reviews	Control	3.66	1.842
	SW	3.46	1.559

We report here the results of the statistical tests conducted to determine the significance of this influence. Where the data was normally distributed, a t-test was used; where the distribution was non-normal, a Mann-Whitney test was used.

Total time on platform. A Mann-Whitney test showed no significant difference between groups ($U=534$, $p=.593$).

Number of sessions. A Mann-Whitney test showed no significant difference between groups ($U=450.5$, $p=.119$).

Number of tools used. A t-test showed no significant difference between groups ($t(65)=-.057$, $p=.955$).

Percentage of programme viewed. A Mann-Whitney test showed no significant difference between groups ($U=514.500$, $p=.567$).

Number of reviews. A t-test showed no significant difference between groups ($t(65)=.479$, $p=.634$).

Clinical Outcomes

Lastly, although we did not expect the addition of the smartwatch watch — a relatively small component in the overall intervention — to impact clinical outcomes, we examined those to rule out the risk of a potential negative effect of the introduction of the smartwatch. Three clinical measurements were conducted by the therapists on site, both before and after treatment, including the PHQ-9, GAD-7, and WSAS questionnaires. Higher scores to the questionnaires represent greater depressive symptoms. Descriptive statistics on the questionnaires scores, per group, can be found in Table 6.6.

The evolution of the scores to each questionnaire, for both intervention groups, is described in Figure 6.31. We observe a strong decreasing trend for the three scores over the course of treatment, in a similar fashion for both groups. In order to assess for statistically significant interaction of the intervention group on the clinical outcomes, two-way repeated measures ANOVA were used.

Table 6.6: Descriptive statistics on the PHQ-9, GAD-7 and WSAS scores, pre and post treatment, per group.

Clinical questionnaire	Measurement point	Group	N	Mean	SD
Patient Health Questionnaire-9	Pre-treatment	Control	32	15.94	5.199
		SW	34	16.24	5.721
	Post-treatment	Control	29	11.76	6.289
		SW	31	11.58	7.270
Generalized Anxiety Disorder-7	Pre-treatment	Control	32	12.41	3.958
		SW	35	11.83	5.762
	Post-treatment	Control	29	9.34	4.561
		SW	32	9.72	6.779
Work and Social Adjustment Scale	Pre-treatment	Control	32	22.63	8.583
		SW	34	21.12	9.810
	Post-treatment	Control	29	18.52	9.767
		SW	31	17.16	11.716

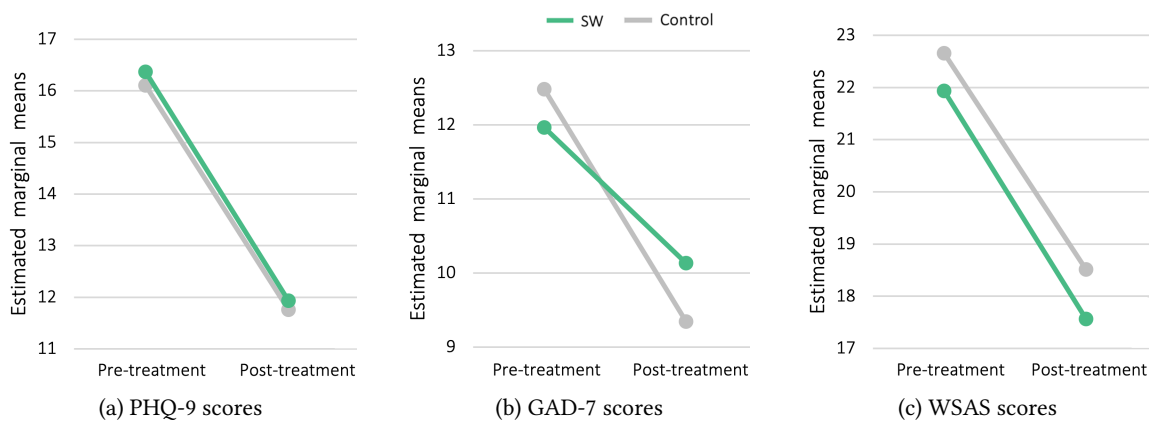


Figure 6.31: Estimated marginal means of the clinical scores pre and post-treatment, in both groups.

There was no evidence of statistically significant interaction between the intervention group and the Patient Health Questionnaire-9 ($F_{(1)}=43.763$, $p=.947$), Generalized Anxiety Disorder ($F_{(1)}=1.131$, $p=.292$) and Work and Social Adjustment Scale ($F_{(1)}=.026$, $p=.862$) scores, before and after treatment. This finding therefore indicates that the introduction of the smartwatch did not impact patients' clinical outcomes gained from treatment.

6.7 Discussion

The impact of the case study findings is threefold. First, the high level of acceptance and use of the self-report on smartwatch shows that patients found value in using the smartwatch as a means to self-report mood, sleep and activity level, within the routine iCBT treatment for depression. Then, considering user acceptance by means of a mixed-method longitudinal approach allowed us to understand the value and limitation of quantitative measurements through acceptance questionnaires, and the importance of repeated qualitative measurements to build a rich understanding of: (i) the evolution of user acceptance over time, and (ii) the specific facilitators and barriers to acceptance of the technology. Finally, the multi-arm context gave us the opportunity to examine between-group difference in patient acceptance, and assess feasibility of

the intervention. Reflecting on these results, we discuss the implications for designing self-monitoring on smartwatch, and conducting user acceptance research in clinical settings.

6.7.1 Understanding Technology Uptake & the Evolution of Acceptance Over Time

This case study relied on existing literature arguing for the influence of user demographics (Venkatesh et al., 2012), the different acceptance mediators (e.g. perceived threat) (Kim & Park, 2012), and satisfaction with treatment (Schlosser et al., 2017; McManama O'Brien et al., 2017; Brittain et al., 2018; Eisenhauer et al., 2017; Niendam et al., 2018) on user acceptance of digital health technologies. Findings revealed that looking through these three lenses provided indeed valuable information on patient acceptance of the self-report on smartwatch. First, analysis of patient demographics and *pre-use acceptability* scores permitted to highlight the influence of the relationship status element. This aligns with the body of work validating the factor *social influence* (also referred to as *social support* or *pressure*) as a determinant of acceptance. Second, analysing the acceptance score obtained for each of the mediators at *pre-use*, *initial use*, and *sustained use*, revealed that these evolved in different manners. Particularly, the lack of statistically significant difference in the overall acceptance and mediator scores at the three time points permitted to rule out potential risks — such as the emergence of obstacles to acceptance in the user journey — and therefore supported the intervention's feasibility and validation. Going further than our study protocol, there might also be value in analysing patient usage behaviour over time, to get a finer-grained understanding of patients' trajectories with the technology. Finally, the strong correlation between *sustained-use acceptance* scores and patient satisfaction with treatment revealed that user acceptance of a small component of a mental health intervention (such as mood self-report) can be linked to satisfaction with the overall intervention. This suggests the potential value of investigating the relationship between these two elements.

6.7.2 From Evaluating Acceptance to Informing the Technology Design

This section provides an example of how the findings of the evaluation study can inform the design of self-monitoring on smartwatch. To do so, we analyse the acceptance facilitators and barriers revealed in the findings, and reflect on their alignment with existing acceptance theories and perspectives specific to the mental health context.

Supporting the Facilitators of Patient Acceptance

People recently diagnosed with mental health difficulties and about to start treatment find themselves in a very vulnerable position. Our findings indicate that one's concerns about their mental health status and desire to get better was a strong motivation for the uptake of self-report on smartwatch. This finding aligns with the *perceived threat* acceptance factor of the HITAM (Kim & Park, 2012), which is defined as the combination of

the user's *health status* and *health beliefs and concerns*. Participants' answers also reflected how acceptance of self-report on smartwatch was intrinsically linked to acceptance of both the CBT treatment, and its internet delivery. For instance, most study patients view the CBT treatment as a last resort to get better, which made them more inclined to try the Mood Monitor, while others struggled with the internet delivery of therapy, which hindered their uptake of the smartwatch app. Therefore, there might be value in extending the scope of study of user acceptance of a specific technological intervention (e.g. self-report delivery on smartwatch) to the broader application context (e.g. iCBT intervention in routine care settings).

The *perceived usefulness* of the smartwatch-delivered self-report was a strong facilitator of patient acceptance throughout the user journey. By encouraging consistent self-monitoring through ecological momentary assessment, the Mood Monitor app supported actual use of self-report — a long-standing challenge in mental health interventions (Spector et al., 1986; Shiffman, 2000) — and therefore patient engagement with a core component of the iCBT intervention. In addition, patients reported that self-report helped them gain awareness of their mood and lifestyle habits, and supported the identification of the positive/negative impact of their sleep and exercise habits, which led to the adoption of healthier behaviours. Seeing improvements in their mood, but more particularly in their ability to handle it in everyday life, was a source of satisfaction for participants — some sharing their intention to buy a smartwatch to continue self-monitoring. This confirms overall *satisfaction* as a facilitator of acceptance (Schlosser et al., 2017; McManama O'Brien et al., 2017; Brittain et al., 2018; Eisenhauer et al., 2017; Niendam et al., 2018), and as mentioned above, this would support examining acceptance within the broader context of the treatment intervention being delivered. Moreover, before first use, patients expected the watch app to be an efficient means to self-monitor, able to support the adoption of healthier habits. Participants responses show that these expectations were met both at *initial use* and *sustained use*, which aligns with the claim that the factor *match with expectations* (Schlosser et al., 2017) is a facilitator of acceptance. However, we bring a nuance to this claim, as some of the patient's expectations might not be met in the short-term use of the technology, without necessarily impeding their acceptance. Indeed, while participants expected the Mood Monitor to help them identify mood patterns, and did not report this was the case at the *initial use* stage (3 weeks in), this did not seem to impact on their *perceived usefulness* of the app. Knowing they are being treated for an estimated 8 weeks, it is possible that patients do not expect seeing clinical outcomes straight away, but do expect seeing them at the end of treatment, as reported in responses at the *sustained use* stage.

The *perceived ease of use* of the Mood Monitor smartwatch app played an important role in patients' acceptance of the technology, reducing the burden often associated with self-monitoring (Choe et al., 2017), through easy and convenient interactions. Most patients mentioned the seamless incorporation of the mood monitoring activity into their daily life, some referring to it as a new habit (SW29). Life *integration* as a facilitator of acceptance aligns with previous literature (Connelly, 2007), however, our participants' responses go further by revealing the importance of *technological integration*, or the fact that the technology integrates among other technologies the user owns — for instance, SW33 reported the smartwatch worked seamlessly with their iPhone and AirPods.

Finally, patients' *attitude* toward use of the self-report on smartwatch was a significant determinant of their acceptance. First, participants' comments on their fear of being judged by others for monitoring their mood in public reveal that the stigma associated with mental health treatment is an important factor to be considered. The discreet nature of the mood reminders, combined with a high level of privacy when interacting with the smartwatch, successfully mitigated patients' perceived stigma — an outcome similar to that of previous studies exploring the delivery of self-report through smartwatches (Motti, 2018; Cormack et al., 2019). It is also worth noting that patients' fear of stigma did not seem to impact their *pre-use acceptability* of the smartwatch app, as it was only mentioned at the *sustained use* stage. This might indicate that motivations to take on the technology superseded the fear of judgement. Second, most participants felt comfortable sharing sensitive data (e.g. daily moods and lifestyle habits) with their clinician. This implies that patients cultivated a certain trust both in how the clinician made use of the data (pertaining to the acceptance factor *healthcare professional relationship* (Dou et al., 2017)), and in how the data was handled by the app (relating to the factor of *trust* (Dhagarra et al., 2020; Connelly, 2007; Harris & Rogers, 2021)). Finally, sharing of this data was motivated by the hope that it would provide more information for the clinician to identify mood patterns, but also guide their recommendations, therefore resulting in a therapy better tailored to their needs. On this last point, patients felt that such data should be used with compassion, in a non-judgemental way, to either help them in identifying mood patterns, or praise their efforts.

Mitigating the Barriers to Patient Acceptance

The study uncovered several obstacles to acceptance of self-report on smartwatch. Firstly, participants reported a number of impediments to the *perceived usefulness* of the Mood Monitor, including a lack of tailoring to their needs when it came to logging lifestyle elements that affected the mood. Although the list provided (sleep, exercise, diet, caffeine, alcohol, medication) was approved by a clinician and based on clinical evidence (e.g. alcohol is a depressant (Schuckit, 1994)), participants felt these did not include common sources of mood change, and called for enabling the customisation of this list. Therefore, a design action might be to extend the available options, while remaining grounded in clinical evidence, an approach also referred to as *enhancing evidence-based treatment standards through practice-based evidence*.

Additionally, patients pointed out that receiving generic encouragements (such as “Well done”) or prompts (e.g. “You could do more exercise”) might negatively impact on their engagement with self-report, as they were perceived as patronising and a cause of frustration. Instead, participants preferred to receive personalised messages, both *triggered by* self-reported data, and *incorporating* collected mood, sleep, and activity data, either through a *factual* approach, prompting summaries self-report data (for instance “Your mood has improved of ‘x’ amount over the last couple of weeks”, SW33) or by means of a more *compassionate* approach, ‘showing concern’ if poor mood, sleep or physical activity is detected (e.g. “Is everything okay? Is there something that you need to talk somebody about?”, SW33). Recent work encourages the latter, more compassionate approach, to the use of self-tracked data (Chatterjee Adnani, 2020). To allow further tailoring,

some patients were comfortable giving the app access to their calendar to adjust the timing of prompts to their schedule (i.e. when they were free), and sharing their location in order to get activity recommendations based on the weather, such as “*It’s a nice sunny day. Why not go out for a walk?*” (SW17).

Comments about how the unreliable behaviour of the app induced self-doubt in patients show that, not only did the *perceived reliability* of the technology impact its *perceived ease of use* aligning with existing theories (Venkatesh & Davis, 2000; Venkatesh & Bala, 2008; Kim & Park, 2012), but in the context of a mental health intervention, it might also trigger depression-related thought processes in patients (Mirels, Greblo, & Dean, 2002). Because technical issues are very common when deploying a novel technology, we recommend clearly communicating to users that such issues pertain to the technology itself, and not to how they interact with it. Patients’ (in)ability to use self-report and the potential discomfort associated with wearing the smartwatch, constituted other sources of anxiety uncovered in the responses. This highlights how familiarity with the technology might impact user acceptance, aligning with the recently published Healthcare Technology Acceptance Model (Harris & Rogers, 2021).

Patients’ *resistance to change*, linked to a disruption of their daily routine induced by the technology, was an obstacle to their acceptance, as theorised by Dou et al. (Dou et al., 2017). However, the present case study went further as it provided examples of how depression symptoms might impact one’s perceived ability to change, sometimes leading to attitudes of self-blame. Therefore, we call for the design of compassionate behavioural change technologies, with particularly caution paid to how self-report data is processed, and results communicated to the user.

This last point ties in with an additional source of anxiety for users, this time linked to the sharing of self-reported data with clinicians. The sensor-based monitoring enabled the continuous collection of sleep and physical activity data, which most participants found helpful and enjoyed visualising. However, making the data accessible to their clinician raised concerns in patients, fearing that they would be ‘under surveillance’ and be pressured to maintain a sleep and exercise routine. This echoes with “an *expectation* that therapists would continuously monitor client mood data” (Matthews & Doherty, 2011, p. 2949). The issue here is two-fold: firstly, a lack of *trust in the technology* and how it handles patient data (Dhagarra et al., 2020; Connelly, 2007); secondly a lack of *trust in the clinician* and how they handle the patient data (Harris & Rogers, 2021; Dou et al., 2017). In order to address the two angles of this issue and reinforce patients’ confidence in the management of their self-report data, we first suggest setting expectations regarding the use of their data, for instance by “repeatedly emphasis[ing] that therapists would only look at their data when conducting the weekly reviews, avoiding any expectation of continuous monitoring” (G. Doherty et al., 2012, p. 1427). Then, we argue for enhancing patient sense of agency by giving them control over which data they wish to share, and which they wish to keep private, for their own personal use.

6.7.3 Conducting Longitudinal Acceptance Research in Clinical Settings

The findings of this study also provide insight into the conduct of acceptance research in clinical settings, allowing us to discuss alignment with existing acceptance models and perspectives specific to the mental health care context, and reflect on the measurement methods and conduct of such research in clinical settings.

Alignment with Acceptance Theories and Perspectives for the Mental Health Context

Findings indicate the potential impact of user demographics on *pre-use acceptability*, and therefore on technology uptake. In the present case study, a demographic element that affected technology acceptability was participants' *relationship status*, which can relate to the acceptance factor of *social influence*. In light of the recently developed acceptance models for the context of digital health technologies, an interesting theoretical contribution would be to examine the relationships that might exist between users' demographic characteristics and newly introduced acceptance factors. While this is not the focus of this thesis, this opens perspectives for future work, for instance exploring the impact users' *education level* might have on their *health beliefs and concerns*.

Although some of the acceptance facilitators and barriers identified were deemed pertinent by patients throughout the three stages of the user journey (such as *perceived efficiency* of the monitoring), others were only brought up before first use, after first use, or after long-term use. For instance, conversations around patients' desire to improve their mental health were situated at *pre-use*, while those around their fear of stigma and the tailoring of the therapy took place after *sustained use* of the smartwatch app. This finding aligns with the TAL continuum (presented in Chapter 3), reinforcing the importance of (i) viewing user acceptance as evolving through use of the technology, and (ii) adopting a longitudinal measurement approach to capture the facilitators and barriers to acceptance present at the different stages of the user journey.

We also observed that the factors identified as playing a role in patient acceptance of self-report were encompassed by the HITAM, but also went beyond. Indeed, the acceptance factors pinpointed belonged to a set of 11 validated models (see Tab. 6.7). In addition, the findings revealed that some factors — namely *relationship status*, *familiarity with technology*, *match with expectations* and *satisfaction* — facilitated acceptance of the self-report activity on smartwatch. These factors do not pertain to validated models. This aligns with findings of our scoping review presented in Chapter 3, reporting that existing acceptance models were often not “adapted to the specific issues of their target population”, with researchers often exploring additional “context-specific constructs”. This also constitutes an insightful perspective on the coverage of the TAC Toolkit, and reinforces the fact that the study of acceptance is exploratory, particularly in the context of mental health technologies for which there exists no specific model of user acceptance.

Table 6.7: Factors influencing patient acceptance of self-report on smartwatch, their origin, and coverage of the TAC toolkit.

Acceptance factors	Models	Validated	TAC Toolkit
Health status	(Kim & Park, 2012)	✓	✓
Health beliefs & concerns	(Kim & Park, 2012; Cheung et al., 2019)	✓	✓
Healthcare professional relationship	(Dou et al., 2017)	✓	✓
Self-image	(Venkatesh & Davis, 2000; Venkatesh & Bala, 2008)	✓	✓
Social pressure	(Venkatesh et al., 2003, 2012; Kim & Park, 2012; Connelly, 2007; Cheung et al., 2019)	✓	✓
Resistance to change	(Dou et al., 2017)	✓	✓
Trust	(Dhagarra et al., 2020; Connelly, 2007; Harris & Rogers, 2021)	✓	✓
Privacy protection	(Schomakers et al., 2019; Dhagarra et al., 2020; C.-L. Hsu et al., 2013)	✓	✓
Technology anxiety	(Venkatesh, 2000; Venkatesh & Bala, 2008; Kim & Park, 2012)	✓	✓
Perceived reliability	(Venkatesh & Davis, 2000; Venkatesh & Bala, 2008; Kim & Park, 2012)	✓	✓
Objective usability	(Venkatesh, 2000; Venkatesh & Bala, 2008; Kim & Park, 2012; Dou et al., 2017)	✓	✓
Integration	(Connelly, 2007)	✓	✓
Familiarity with technology	(Acharya & Mekker, 2022; Choi, 2020)	In some contexts	
Relationship status	—		
Match with expectations	—		
Satisfaction	—		

Mixed-Measurement Methods to Get a Rich Understanding of User Acceptance

The acceptance scores and participants' responses to questionnaires and interviews reveal discrepancies in the acceptance factors deemed important by patients. For instance, while the *perceived threat* acceptance score remained high throughout the user journey — indicating a desire to improve their mental health during the 8-week treatment period — participants only discussed this factor at the *pre-use* stage. This supports the importance of gathering users' qualitative feedback at different milestones of the user journey, in order to give them an opportunity to share what specific factors are important to them at that moment in time. In addition, although a body of work equated *satisfaction* to acceptance (Schlosser et al., 2017; Gordon et al., 2017; J. O'Brien et al., 2017; Sureshkumar et al., 2016; Brittain et al., 2018; Niendam et al., 2018; Jacobson et al., 2018; Eisenhauer et al., 2017; Isetta et al., 2017; Carter et al., 2013; Patel et al., 2013), the findings of this research show that measuring satisfaction alone does not provide an understanding of the factors that determine patients' usage behaviour with the technology. On a higher level, the approach adopted to elicit patients' opinion

greatly impacts the outcome of an acceptance study in terms of understanding which factors play a role at each stage. By adopting a methodology combining open questions with targeted questions, we respectively (i) gave patients the opportunity to explain what acceptance factor mattered to them most at specific time points, and (ii) orientated the discussion towards aspects that patients might have perceived as details of lesser importance, but which might still affect their technology acceptance. Therefore, we recommend measuring patient acceptance using a mixed-methods approach combining the use of both quantitative and qualitative data, to maximise insight and understanding into the evolution of patient acceptance of a technology.

Furthermore, the use of a consistent acceptance questionnaire allowed for between-group comparison of patient acceptance of the self-report delivery platforms. It also showed that comparing overall user acceptance between group was not sufficient to draw helpful conclusions, but that examining acceptance mediators scores could indicate where the introduction of smartwatch did better than the other delivery means – e.g. the case study showed a statistically significant difference in *attitude* scores, indicating that patients felt more comfortable self-monitoring on smartwatch.

Patient Acceptance of Self-Report on Smartwatch as part of a Broader Context

In the case study, we examined the study of acceptance in the context of a validated routine clinical intervention. Because such routine validated interventions are likely well accepted by patients, we chose to explore acceptance of a novel component of the intervention: self-report of mood and lifestyle habits on smartwatch. This required isolating aspects of the intervention related to the self-report component (e.g. sharing self-reported mood data with clinician), and studying their acceptance. Yet, in the context of a study exploring a novel form of treatment, there might be value in examining technology acceptance along with *treatment acceptance*. Treatment acceptance is defined as “the degree to which an individual perceives a treatment protocol as appropriate, fair, and reasonable for a given population or problem and any acceptability test is accepted as an outcome” (Babiano-Espinosa et al., 2019, p. 4), and is often measured through uptake and dropout rates (A. Martin, Rauh, Fichter, & Rief, 2007). Moreover, treatment delivery (in our case, internet delivery of the CBT intervention) might also impact user acceptance of a specific intervention component. Reviewing previous literature might help determine the benefit of investigating user acceptance of treatment delivery – for instance, user acceptance of computerised CBT has already been extensively explored in previous works (Rost et al., 2017).

The Logistics of Conducting Acceptance Research in Clinical Settings

Evaluating patient acceptance of self-report on smartwatch presented multiple challenges. First, ethics approval for conducting such study is required. In our case, an application for ethics approval involved a submission to the Health Research Authority, and subsequent review by a NHS Research Ethics Committee. This resulted in a 6-month iterative process of revision of the study design and administrative work with the clinical site, until agreement was reached and approval granted. Then, recruitment itself presents its own

challenges, from training clinicians to check patient eligibility for the research to adjusting the recruitment strategy to unforeseen events. Particularly for this study, the COVID-19 pandemic had induced an additional workload for clinicians, drastically changing their work practices, most of them working from home. Facing an initial low number of patients assessed for eligibility, we received ethics approval to amend the study protocol and adjust our recruitment strategy. Additional logistics apply for studies like this one, involving the sending of hardware devices to participants, and managing their return to the research team. A significant extra overhead in terms of study design was involved in integrating these steps into the triage and recruitment process in a time-sensitive study. Finally, interviewing patients from an identified vulnerable group requires protocols in place to appropriately handle any risk management issue that could arise.

6.8 Conclusion

This chapter presented the results of the clinical case study exploring the longitudinal approach to evaluating acceptance proposed in Chapter 5. By doing so, it provided a practical example of how this approach could build a rich picture of user acceptance of a mental health care technology, and inform its design. The case study took the form of an 8-week randomised controlled trial involving 69 patients, and it evaluated user acceptance of the Mood Monitor smartwatch app in the context of a routine iCBT intervention for depression. Longitudinal measurement of patient acceptance followed the TAL timeline (*pre-use, initial use, sustained use*). The mixed measurement method adopted involved an exploration of (i) patients' demographics in relation to *pre-use acceptability*, (ii) acceptance mediators at the three acceptance stages, and (iii) patient satisfaction in relation to *sustained use acceptance*; this was complemented by (iv) qualitative data from open-ended questions and post-study interviews. This method enabled the identification of key facilitators and barriers to user acceptance of self-report on smartwatch, and therefore informed the technology design. The controlled nature of the study allowed us to gain insight into between-group differences (that might have been introduced by the addition of the smartwatch) in terms of user acceptance of self-report, its actual use, usage of the iCBT programme, and clinical outcomes. It also revealed the challenges of measuring acceptance in multi-arm studies. Finally, this chapter reflected on the challenges of conducting acceptance research in clinical settings, including a lack of acceptance models adapted to mental health technologies, the need to adopt a longitudinal, mixed-measurement approach, and to consider patient acceptance within the application context, as well as the particular logistics involved in the conduct of real-world clinical acceptance research.

Chapter 7

Discussion

This thesis investigates the theoretical landscape and research practice around user acceptance, and explores novel approaches to addressing user acceptance in design and research practice. In the work described in this thesis, we have considered the question of user acceptance of health and wellbeing technologies starting with an extensive review of existing theories, and examined areas of convergence and divergence with current research practices defining, discussing, designing for and measuring acceptance. This revealed existing challenges in designing for and longitudinally measuring user acceptance, resulting in a lack of studies addressing the concept in the design process, and evaluations methods inconsistent with existing theories. Building on this knowledge, we investigated how design for acceptance of health and wellbeing technologies could be supported in design practice. This led to the creation of the TAC toolkit and associated method, and its evaluation with 21 designers. The final aspect of acceptance research that we examined was the evaluation of user acceptance in clinical settings. We proposed a theory-based longitudinal measurement approach, and explored its operationalisation in a randomised controlled clinical trial in a mental health care context. This final chapter first revisits the research questions and reflects on the contributions of this thesis. Then, it examines perspectives overlapping with user acceptance. Finally, this chapter concludes by calling for future research aiming to revise and advance the theoretical frameworks on user acceptance, design for user trajectories towards acceptance of health and wellbeing technologies, and adopt longitudinal approaches to the investigation of user acceptance within a human-centred design process.

7.1 The Research Questions & Contributions

The three research questions stated in Chapter 1 aimed to (i) take stock of the theories and research practice addressing user acceptance, (ii) explore how to bridge theories and design practice, and (iii) examine how to longitudinally measure user acceptance. This section details how the work of this thesis has addressed these research questions within the context of digital mental health, and describes the contributions to the HCI field.

7.1.1 Understanding User Acceptance Theory & Exploring its Practical Application

Research Question 1: How is user acceptance of health and wellbeing technologies defined, discussed, designed for, and measured, both in theory and in practice?

Along with the range of existing approaches for the design health and wellbeing technologies come challenges. Among these, *user acceptance* is a major issue for the successful uptake and use of healthcare technologies (Sekhon et al., 2017). Chapter 2 reviewed the theoretical frameworks of user acceptance, a dense set of definitions (for *acceptability*, *acceptance*, and *adoption*), models — in particular those for digital health acceptance (Kim & Park, 2012; C.-L. Hsu et al., 2013; Dou et al., 2017; Dhagarra et al., 2020) — and measurement methods, which includes a growing body of work investigating the dynamic, multi-stage nature of the process (Sekhon et al., 2017; N. Martin et al., 2015; Distler et al., 2018; Terrade et al., 2009; Garces et al., 2016; Somat et al., 2012; Rogers, 1983).

To advance the knowledge on user acceptance of health and wellbeing technologies, Chapter 3 explored how digital health and mental health researchers understood the notion of user acceptance, and how they addressed this issue in the evaluation of technologies, highlighting areas of convergence and divergence with the existing theories in the ways that the concept was defined, discussed, and measured by researchers. In particular, this review pointed out the small number of studies re-using the full set of constructs provided by validated acceptance models (Zhu et al., 2018; Y. Chen et al., 2017; Wang et al., 2016; De Vito Dabbs et al., 2013). Together, Chapters 2 & 3 showed that the large, complex, ambiguous set of theories around user acceptance led to an inconsistent application of theory into research practice measuring user acceptance of technologies for health and mental health.

In light of this literature review, we defined *user acceptance* as individuals' perception of the technology, leading to its use or non-use, and distinguished it from the *user acceptance journey*, a sequence of experiences, each susceptible to changing the user's perception of the technology. Finally, we proposed the Technology Acceptance Lifecycle (TAL), a temporal, theory-based model consolidating existing definitions, articulating the different stages of technology acceptance — namely *pre-use acceptability*, *initial use acceptance*, and *sustained use acceptance* — and providing an explicit terminology.

7.1.2 Bridging the User Acceptance Theories and Real Design Practice

Research Question 2: How can the theoretical landscape of user acceptance, including the temporal dimension of the process, be made more accessible to designers of health and wellbeing technologies, and incorporated into real design practice?

Investigating acceptance as early as the design stage has been showed to be helpful to inform design work (Matthews et al., 2015) and reduce the risk of rejection or abandonment of technology, particularly, when involving health care service users in the design process (Thieme et al., 2020). Chapter 2 revealed the complexity of designing for acceptance, with studies often considering a small subset of validated acceptance factors (Wartena & van Dijk, 2013; Eilu, 2021; Van Der Geest & Buimer, 2015), or reviewing the acceptance literature to inform their design approach (Detjen et al., 2021).

These challenges translated into a lack of consideration of user acceptance at the design stage (see Chapter 3), and led us to investigate how we could help designers of health and wellbeing technologies gain a rich understanding of the process of acceptance, and apply this knowledge into their practice to design technologies which are accepted by people.

In Chapter 4, we explored a way to support designers in addressing user acceptance of health and wellbeing technologies at design stage. This approach took the form of the TAC toolkit, a novel, theory-based design tool and method, embedding a large set of factors of acceptance from validated models (F. D. Davis et al., 1989; Venkatesh & Davis, 2000; Venkatesh, 2000; Venkatesh & Bala, 2008; Venkatesh et al., 2003, 2012; Connelly, 2007; Kim & Park, 2012; C.-L. Hsu et al., 2013; Dou et al., 2017; Cheung et al., 2019; Schomakers et al., 2019; Dhagarra et al., 2020), and the temporal dimension of the process.

Results of a practical evaluation of the toolkit with 21 designers demonstrated that such toolkits and associated methods could revise and extend designers' knowledge of technology acceptance, foster their appreciation, empathy and ethical values while designing for acceptance, and motivate their future use in the practice of design. This work illustrated that, by conveying validated acceptance factors and the longitudinal aspect of the process in an accessible manner, the TAC toolkit method could efficiently support design for acceptance.

7.1.3 Re-Thinking the Measurement of User Acceptance

Research Question 3: How can we evaluate user acceptance longitudinally, in a mental health care context, and draw on the results to inform the technology design? What are the challenges of conducting user acceptance research in clinical settings?

Having explored how to design for acceptance, the final step of this research was to look into the empirical exploration of user acceptance. Chapter 5 examined a novel, theory-based, longitudinal approach to the

measurement of acceptance, relying on the Technology Acceptance Lifecycle timeline (*pre-use*, *initial use*, *sustained use*). We looked at the particular case of mental health care, an under-explored context (see Chapter 2) albeit particularly challenging in terms of user acceptance due to users' vulnerability, sensitive data, and perceived stigma (Sanches et al., 2019a; Coman & Sas, 2016). We described the protocol for a case study exploring this method, by means of an 8-week randomised controlled clinical trial evaluating user acceptance of a self-monitoring technology in patients undergoing depression treatment. We then reflected on the challenges of designing studies for the longitudinal evaluation of user acceptance research in a clinical context, including in terms of finding and adapting measurement tools, comparing acceptance between intervention groups, and measuring acceptance longitudinally.

The clinical case study involved 69 patients, and the results were reported in Chapter 6. We first analysed the longitudinal acceptance data, exploring (i) patients' demographics in relation to *pre-use acceptability*, (ii) acceptance mediators at the three acceptance stages, and (iii) patient satisfaction in relation to *sustained use acceptance*.

We then drew on the rich dataset collected to identify key facilitators and barriers to user acceptance of self-report on smartwatch, and showed how these outcomes can be used to inform the technology design.

Finally, drawing on the findings, we discussed the challenges of conducting user acceptance research in clinical settings, in terms of alignment with existing acceptance models and the emergence of new perspectives, and a reflection on the measurement methods and on the conduct of such research in clinical settings.

7.2 Other Perspectives Overlapping with User Acceptance

User acceptance research is primarily concerned with identifying barriers and facilitators to technology use. In the context of digital health and wellbeing, acceptance research adopts the more focused lens of validated models of digital health acceptance, and their associated sets of factors. These sets of measurable concepts constitute a guide for the exploration of user acceptance. Throughout our review of the literature, we have come across bodies of work on a range of HCI concepts that overlap with certain aspects of user acceptance research. This section describes the commonalities user acceptance research shares with the perspectives of user experience, engagement, and ethics.

7.2.1 User Experience

User experience research is interested in understanding “how humans experience the interaction with technological artefacts” (Glanzni, 2012, p. 236), and explores how experience is formed, what different aspects it comprises, and how to design for particular user experiences (Karapanos, Zimmerman, Forlizzi, & Martens, 2009b). User experience (UX) has been defined by the International Organization for Standardization (ISO) as “user’s perceptions and responses that result from the use and/or anticipated use of a system, product or service” (International Organization for Standardization (ISO), 2019, p. 3). While this definition of UX is

close to that of *user acceptance* (i.e. individuals' perception of the technology, leading to its use or non-use), acceptance research is interested in the *mechanisms* that translate this perception of technology into actual use. Other similarities between the two concepts can be found in the model proposed by ISO 9241-210, articulating the three phases of user experience: *anticipated use*, *during use*, and *after use*. This model therefore pushes to consider UX a concept evolving through use of the technology. This temporal conception of users' relationship with technology differs from that proposed by acceptance research, which distinguishes between *initial use* and *sustained use* — where the former relates to the novelty of technology, and discovery of the features and interactions by the user, and the latter to prolonged use of the system. In the context of digital interventions for treatment and self-management, often used for long period of times (e.g. glucose monitoring systems, symptoms tracking apps), users' experience and perception of the technology are likely to evolve through use. Therefore, we believe that there is value in looking at the *after use* stage with more granularity.

In less recent literature, we observe two frameworks making the distinction between short and long-term. One is ContinUE [continuous user experience], Pohlmeier and colleagues' user experience lifecycle model. This model integrates the three stages of the ISO model — *pre-use*, *use*, and *post-use* (involving immediate effects) — and adds *repetitive use* (involving short and long-term effects), and an *evaluation* stage where fulfilment of expectations is assessed, and leading (or not) to *re-use* of the system.

A second framework is Karapanos and colleagues' Temporality of Experience model, featuring the stages of *anticipation*, *orientation*, *incorporation*, and *identification*. The milestones punctuating the user experience process as described in this framework aligns particularly well with the Technology Acceptance Lifecycle milestones — *pre-use*, *initial use*, and *sustained use*. Furthermore, Karapanos et al.'s framework proposes the stage of technology *incorporation* ("how the product becomes meaningful in our daily lives") and *identification* (the participation of technology "in our social interactions, communicating parts of our self-identity that serve to either differentiate us from others or connect us to others by creating a sense of community"). This might help refine the *adoption* milestone of the TAL, if we equate *pre-adoption* (TAL) to technology *incorporation*, and *post-adoption* (TAL) to *identification*.

Finally, while *experience* is considered to be a factor of user acceptance (Venkatesh & Davis, 2000; Venkatesh & Bala, 2008; Venkatesh et al., 2003, 2012) and the two concepts look at user's relationship with technology through different lenses, there might be value in combining the two bodies of work on the temporal dimension of the processes, for instance as to refine the milestones of the user journey with technology.

7.2.2 User Engagement

User engagement research is concerned with users' interactions with the technology. A large number of definitions of the concept exist; Doherty and Doherty examined 102 of them in their review (K. Doherty & Doherty, 2018b). UX, user engagement, and user acceptance research are all interested in *usage behaviour*. If traditionally user engagement research was concerned with maximising usage of technology (Zou et al., 2019; Scholz & Smith, 2016; Dobrian et al., 2011), the evolution of user needs (e.g. technology abstinence),

forms of interventions (e.g. biofeedback), and contexts of use (e.g. health and wellbeing purposes) triggered a shift towards the search of more meaningful interactions with technology (H. L. O'Brien, Roll, Kampen, & Davoudi, 2021; Cecchinato et al., 2019). This shift to a more personal use of technology might be supported by previous acceptance studies, which have uncovered a wide range of antecedents to usage pertaining to individuality, personal social context and relationship with technology. For instance, we find similarities between acceptance antecedents (such as *objective usability*, *perceived enjoyment*, *social support*), and the design strategies for user engagement outlined by Doherty and Doherty: (i) ensuring usability, (ii) managing user resources, (iii) immersing users, (iv) engaging users emotionally, (v) inspiring fun, (vi) enabling exploration, (vii) supporting social connectedness, (viii) enabling optimal experience, and (ix) promoting repeated use (K. Doherty & Doherty, 2018b).

As we have seen in the scoping review in Chapter 3, user acceptance is in practice often reduced to the sole construct of *usage behaviour*, resulting in researchers measuring acceptance through system usage. Simplification of a complex concept to enable its measurement is also found in user engagement literature, where definitions equated *long-term engagement* to “the degree of voluntary use of a system along a wide period of time” (Febretti & Garzotto, 2009, p. 4063) or the “maintenance of user adherence to a desired interaction usage pattern” (Bickmore, Consolvo, & Intille, 2009, p. 4807). On the longitudinal dimension of engagement, Doherty and Doherty explained:

« *Experience is cumulative (Carrigy, Naliuka, Paterson, & Haahr, 2010) motivations for use evolve over time (Naps et al., 2002; Snow, Buys, Roe, & Brereton, 2013; Van Vugt, Hoorn, Konijn, & de Bie Dimitriadou, 2006), and so engagement cannot be fully understood without longitudinal analysis (M. Chen, Kolko, Cuddihy, & Medina, 2011).* » (K. Doherty & Doherty, 2018b, p. 99:25)

This highlights the evolving nature of the construct, the crucial role of ‘motivations for use’, and the need for a longitudinal measurement approach to assess the concept, all aspects also relating to the user acceptance process. In addition, the authors linked the notion of long-term engagement to user *experience*, a factor of acceptance in the TAM2 (Venkatesh & Davis, 2000), TAM3 (Venkatesh & Bala, 2008), UTAUT (Venkatesh et al., 2003), UTAUT2 (Venkatesh et al., 2012), and Dou et al.’s model (Dou et al., 2017).

However, while this review on engagement pointed out a lack of discussion in the literature around disengagement and technology non-use (K. Doherty & Doherty, 2018b), these challenges are in fact addressed in user acceptance research, which specifically aims to identify obstacles and enablers of technology use.

Finally, recent work includes Perski and colleagues’ conceptual framework on engagement with digital behaviour change interventions (Perski, Blandford, West, & Michie, 2017). Integrating this framework, as well as Sekhon and colleagues’ acceptability framework (Sekhon et al., 2017), the dynamic model proposed by Perski and Short in 2021 linked for the concepts of acceptability, user engagement, and intervention effectiveness (Perski & Short, 2021b). The authors argued:

« Acceptability may usefully be considered an emergent property of a complex, adaptive system of interacting components (e.g., beliefs, knowledge, affective attitude), which in turn influences

(and is influenced by) user engagement and intervention effectiveness. » (Perski & Short, 2021b, p. 1474).

7.2.3 Ethics

Also sharing commonalities with user acceptance research is the domain of ethics. In the transdisciplinary ethical principles developed by Bowie-DaBreo and colleagues, we find a number of qualities directly related to factors of acceptance. These include, for instance, *knowledge and skillset* relating to the factor *self-efficacy* (Taylor & Todd, 1995; Venkatesh, 2000; Venkatesh & Bala, 2008; Dou et al., 2017), *reliability* relating to the factor *output quality* (Venkatesh & Davis, 2000; Venkatesh & Bala, 2008; Kim & Park, 2012), *trustworthiness* relating to the factor *trust* (Dhagarra et al., 2020), and *privacy* relating to the factor *privacy concerns* (Dhagarra et al., 2020; C.-L. Hsu et al., 2013).

Other recent research linking ethics and user acceptance is a review by Sekhon and colleagues' proposing the Theoretical Framework of Acceptability of healthcare interventions (Sekhon et al., 2017). This multi-stage model — going from *pre-use*, through *use*, to *post-use* — introduces *ethicality* as a factor of acceptability, defined as “the extent to which the intervention has good fit with an individual’s value system” (Sekhon et al., 2017, p. 8). This construct can be related to the acceptance factor *compatibility*, or “the degree to which an innovation is perceived as compatible with [one’s] existing values, past experiences, and needs” (Rogers, 1983, p. 224) — present in the Decomposed Theory of Planned Behaviour (Taylor & Todd, 1995), but discarded in subsequent acceptance models.

Finally, we have seen through the COVID-19 pandemic that worldwide health threats could lead to a fast-paced revolution of health and mental health care services, and the mandates for the use of community health technologies within some settings (Paska, 2021; Perski & Short, 2021a; Tabourdeau & Grange, 2020). But such rapid deployment of technology, changing the routine for diagnosis, treatment, self and community health management raises a number of ethical concerns, and a different perspective on user acceptance. Particularly, the emergence of a new context of use which is the enforced use of community health apps by governments (Basu, 2021) constitutes a shift from the voluntary use context which user acceptance research had focused on previously. In addition to raising additional ethical concerns, this introduces new acceptance challenges, for instance related to legal repercussions for non-use of the technology. We believe that these new contexts of use of health and wellbeing technologies will require revising user acceptance theories through the lens of ethical frameworks and in collaboration with ethics researchers.

7.3 Future Work

The rapid, constant evolution of health and mental health technologies, but also their context of use, presents many opportunities for future work. This section describes possible advancements for the field with regards to the theoretical frameworks, design methods, and research practice.

7.3.1 Revising & Advancing the Theoretical Frameworks

While the theoretical landscape of user acceptance is large, we see two opportunities for improvement, namely in the revision of existing models to incorporate temporality, and the extension of theories to cover under-explored and new contexts of use of technology.

Revising Existing Models to Integrate the Temporal Dimension

Models of user acceptance constitute a basis for the research design and the measurement of user acceptance. In line with the literature, we have argued that user acceptance is a multi-stage process and that acceptance factors may play a different role at different stages of the user journey with technology. Although early works in the field aligned with this stance and employed longitudinal studies for the validation of technology acceptance models, recent work focused on practical application of the concept tends to assess user acceptance as a point measure. Therefore, we suggest rendering temporality visible in existing models, and reporting on differences of weight of the acceptance factors at the different measurement time points. This information might help support study design, for instance by tailoring acceptance questionnaires to elicit responses on factors particularly relevant at *pre-use*, *initial use*, or *sustained use*. However, the particular context of technologies for health and mental health care requires flexibility in the consideration of temporality. Indeed, interventions for diagnosis, treatment, or self-management rely on different time scales; for instance, the *initial use* stage for a diagnosis intervention might be of a couple of minutes, while the same stage for a treatment intervention might last a couple of weeks. This time scale is also likely to differ depending on other factors, such as the type and severity of condition. Thus, more work is needed to investigate the timing of the milestones of the user acceptance journey.

Investigating Under-Explored and New Contexts

In the absence of acceptance theories and models for the case of mental health technologies, we argued in our clinical case study for considering a broad range of factors, before focusing on the subset of factors deemed empirically relevant. While we acknowledge the individual specificities of mental health interventions and the need for tailored research practices, there is a need for validated longitudinal measurement approaches to serve as a basis for the study of user acceptance of mental wellbeing technologies. Such methods could emerge from psychology theories, empirical evidence, or participatory design, and should be validated with the target population (such as people diagnosed with mental health difficulties).

Moreover, user acceptance research tends to focus on particular populations, for instance in terms of age, (e.g. adults), ethnicity (e.g. White), or geographical regions (e.g. high-income countries). Particularly, our scoping review in Chapter 3 revealed that many researchers felt compelled to create their own acceptance model or measurement tool as the validated options did not fit their target population. There needs to be more efforts from the community, not only to (i) address user acceptance in the design and trial of new health

and wellbeing technologies, but also to (ii) ensure diversity in the population of users involved in the design and measurement of acceptance.

Finally, this thesis focused on the case of health and mental health technologies, yet, we observe the emergence of new contexts of care and an increasing integration of technology. Such contexts include wellbeing and public health — for instance with the case of governments enforcing the use of public health apps. The changing scene of care, together with the rapid evolution of technology, might be synonym of user acceptance theories and models evolving in the near future.

7.3.2 Supporting Designers in Addressing User Acceptance

The scoping review in Chapter 3 showed that a wide range of interpretations of the concept of user acceptance exist in the research community, often reducing the concept to a single measurable element (e.g. usability). This highlighted the need for tools and methodologies to support designers of health and wellbeing technologies in addressing user acceptance in their practice. In response, we proposed the TAC toolkit and associated method, and a longitudinal approach to measure user acceptance in clinical settings. Drawing on the findings of these two studies, we propose the following guidelines for future tools and methods aiming to facilitate the application of user acceptance theory into design and evaluation practice.

Educating on the Factors of Acceptance. User acceptance is a complex, multi-dimensional concept, for which an extensive body of theories exist. We thus argue that the first step towards addressing user acceptance in practice is getting a nuanced understand of the construct. While a wide range of factors have proven to influence user acceptance, we see two theory-based approaches to help designers leverage these factors. A first approach is to narrow down this large set by selecting a subset of factors relevant to the study field of interest — for instance, by considering one particular validated model for user acceptance of wearable healthcare technology (Cheung et al., 2019). For research fields for which the theoretical landscape on user acceptance is saturated, or on the contrary non-existent, considering a broad range of validated acceptance factors from different models might be a more adapted approach. When designing the TAC toolkit, we adopted the second approach in an attempt to map known acceptance factors for health and wellbeing technologies.

Educating on the Temporal Dimension of Acceptance. The observation in Chapter 3 that most studies assessed user acceptance by means of a discrete measure (mostly at *sustained use*) despite evidence of the evolving nature of users' perception of the technology (see Chapter 2) brought us to make temporality a core element of the TAC toolkit and method, by providing multi-choice temporal scenarios and incorporating the TAL stages into the think-space. We suggest that future work aiming to support designers in addressing acceptance renders the temporal dimension of the process explicit, and relates the user acceptance journey timeline to that of the user journey — which most designers are familiar with.

Addressing Acceptance in the Design Process. Although previous work has argued for investigation of user acceptance at design stage with healthcare users (Thieme et al., 2020; Matthews et al., 2015), Chapter 3 showed that technology acceptance was rarely investigated at the design stage. In addition, Chapter 2 & 6 revealed

both the necessity and complexity of evaluating health and wellbeing technologies in clinical settings. Therefore, we strongly believe that the question of user acceptance should be addressed (or at least reflected upon) at early design stage, and a study conducted by a another research group is currently exploring the use of the TAC toolkit in workshops early in design. Yet, more research is needed to determine when in the design process should user acceptance be investigated, in order to provide a valuable, informative contribution to the technology design. There would also be value in exploring different methodologies for using the TAC toolkit in other design contexts, such as prototyping sessions or activities involving users.

Sensitising to Different User Trajectories. Because one person's journey towards acceptance is unique and motivated by elements intrinsically linked to their characteristics, environment and relationship to technology, designing technologies that are accepted by users requires considering different user trajectories. This can be by means of multi-choice temporal scenarios as explored in the TAC toolkit study, but also through the direct involvement of users in the design process. Although it is impossible to design a technology that is accepted by everyone, we believe that reflecting on user trajectories involving acceptance issues of different severity would help design for a greater diversity of users.

Capturing a Rich Picture of User Acceptance. We should take advantage of validated measurement tools, such as questionnaires and scales, to assess the degree of technology acceptance, and allow for between-group comparison in controlled trials. However, the outcomes provided by these tools in terms of design actions might be limited. Therefore, we recommend adopting a mixed-method approach to the measurement of acceptance, including quantitative and qualitative components, to gain a rich understanding of facilitators and barriers to acceptance, and support the formulation of design actions.

Adopting a Longitudinal Measurement Approach. The body of work on temporality in user acceptance highlighted the importance of considering the concept more as a dynamic process. In addition, our clinical case study revealed that factors influencing user acceptance differed at *pre-use*, *initial use*, and *sustained use*. We thus recommend adopting a longitudinal method to the assessment of acceptance, and reflecting on the evolution between measures as much as on the measures themselves.

Considering the Broader Interventional Context. Health and mental health interventions are often part of a broader, more complex service. Many applications of novel technologies might explore the integration of a new component into an existing larger intervention. This was the case for our clinical study, investigating the addition of self-report on smartwatch within a routine iCBT intervention. However, measuring and interpreting user acceptance of an isolated component in the overall intervention was not straightforward. It involved reflecting on meaningful between-group comparisons, isolating elements of the intervention related to the studied component, and measuring acceptance of these specific elements. In light of this work, we believe that the research community would benefit from guidelines for the measurement of user acceptance, particularly in multi-arm studies. While the case study's iCBT intervention was widely used and accepted in routine care, other studies exploring novel forms of treatment or treatment delivery might find value in examining technology acceptance along with *treatment acceptance*, as these might impact each other.

Conducting Acceptance Research in Clinical Settings. Evaluating user acceptance of health and wellbeing

technologies in real use settings is essential to build a realistic picture of users' perception of the technology. However, we have seen in Chapters 2 & 6 that the conduct of clinical studies is associated with many logistical challenges. These obstacles make the involvement of users in the design process but also evaluation studies difficult. The introduction of the smartwatch app into a routine iCBT intervention was a particularly interesting case to study through the lens of acceptance, as it re-purposed a device of everyday life for use in therapy, and involved recent technological innovations such as collection of physiological data. This study was the first to investigate user acceptance of a smartwatch app in the context of a routine treatment for depression. Despite the complex logistics of such trials (detailed in Chapter 6) related to ethics approval, patients recruitment and management, collaboration with clinicians in the context of a global pandemic, and sending of hardware devices, the study was carried out successfully and the self-report delivery on smartwatch was highly accepted by patients. In light of this experience, we argue that acceptance studies involving use of hardware in sensitive contexts (like mental health interventions) might benefit from privileging users' diversity over numbers, as to gain insight into a variety of trajectories. Moreover, while randomized controlled trials are needed to evaluate feasibility and efficacy of health and mental health interventions, this thesis provided an example of how researchers might use such opportunities to evaluate acceptance. Yet, we have seen that multi-arm settings might imply limitations, (such as difficult between-group comparisons), and limitations when some contexts do not present a control element for comparison.

Finally, this thesis provided methods as well as practical examples of how user acceptance can be designed for, and how the concept can be longitudinally measured in clinical settings.

Chapter 8

Conclusion

Technology has opened the door to a multitude of opportunities for improving health and mental health care. Particularly, recent innovations such as wearable devices, embedded sensors, and machine learning show great potential for enhancing traditional interventions in terms of effectiveness, tailoring, and convenience. However, a lack of user acceptance will impede individuals' uptake and long-term use of the technology, provoking rejection or discontinued use of digital health interventions. User acceptance is therefore a core challenge for successful health and mental health technologies, and a question that requires consideration as early as design stage, and throughout the technology lifecycle.

This thesis examined how to support design for and measurement of user acceptance of health and wellbeing technologies. It asked how to guide designers of health and wellbeing technologies in leveraging the theory of user acceptance in design practice, and how to capture a rich picture of the evolution of user acceptance in clinical settings. Through collaboration with digital health researchers, designers, patients, and mental health professionals, this thesis attempted to bridge the gap between theory and practice.

The first contribution of this thesis was to advance our knowledge of how user acceptance is addressed in research practice, including how the concept is defined, discussed, designed for, and measured. It identified differences that exist between research practice and theoretical frameworks, and contributed to clarifying the process of technology acceptance by (i) defining *user acceptance* and the *user acceptance journey*, and (ii) proposing the Technology Acceptance Lifecycle (TAL), a temporal, theory-based model consolidating existing definitions, articulating the different stages of technology acceptance — namely *pre-use acceptability*, *initial use acceptance*, and *sustained use acceptance* — and providing an explicit terminology.

This thesis then proposed and examined a novel, theory-based approach to designing for user acceptance of health and mental health care technologies. This approach consisted of a design tool and method, the *TAC toolkit*, which supported designers in leveraging user acceptance theory in the design of health and wellbeing technologies. The *TAC toolkit* method was evaluated by means of 7 workshops with 21 designers of digital health and wellbeing technologies. Findings indicated that the method (i) revised and extended designers' knowledge of user acceptance, (ii) fostered their appreciation, empathy, and ethical values while designing

for acceptance, and (iii) motivated the future use of the toolkit in their design practice.

This thesis finally investigated a novel, theory-based longitudinal approach to evaluating user acceptance in the context of mental health care, following the TAL timeline. As a practical example to implement such a longitudinal theory-based approach, we developed the *Mood Monitor* — an application for smartwatch intended to facilitate mood and lifestyle habits self-monitoring in depression treatment. This practical case study took the form of an 8-week randomised controlled clinical trial (n=69), examining patient acceptance of the Mood Monitor watch app in a routine internet-delivered therapy for depression. This thesis showed how the results of the case study exploring the longitudinal measurement method could inform the technology design, and identified challenges of conducting user acceptance research in clinical settings.

This thesis thus enriches the HCI field with a better understanding of user acceptance, and how the concept can be designed for and measured, in the context of digital health and wellbeing.

Chapter A

TAC Cards

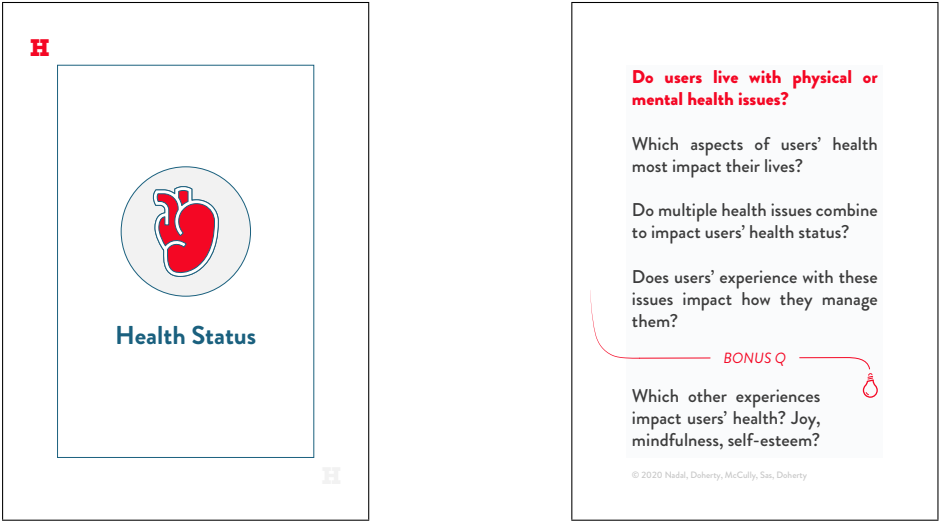


Figure A.1: Card for the factor *health status* (front and back).

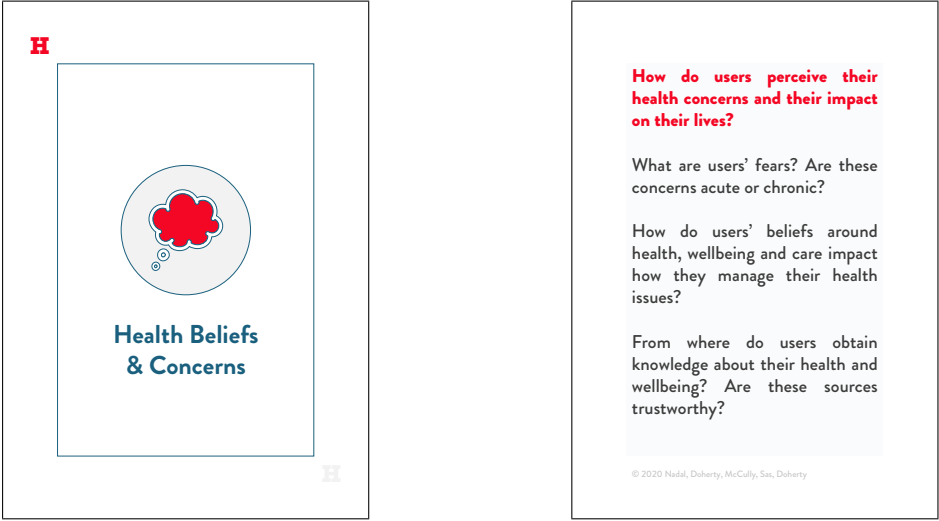


Figure A.2: Card for the factor *health beliefs and concerns* (front and back).

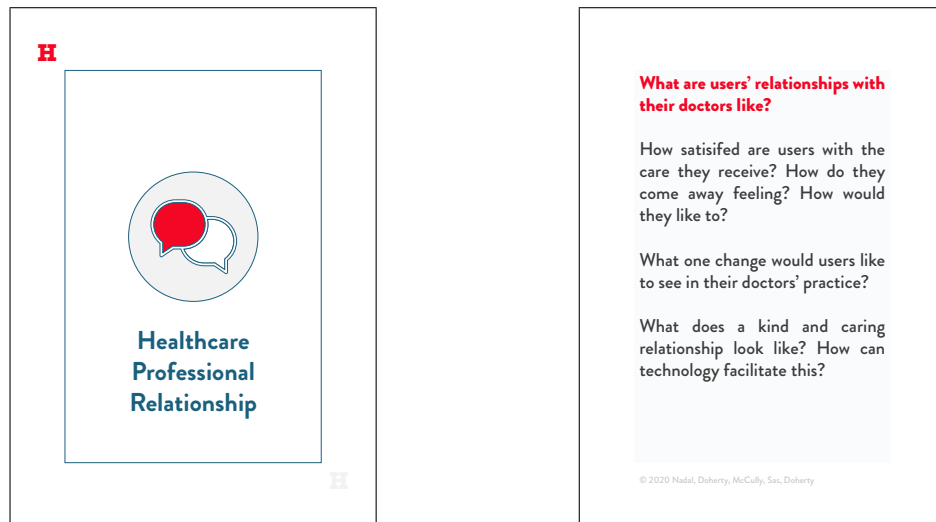


Figure A.3: Card for the factor *healthcare professional relationship* (front and back).

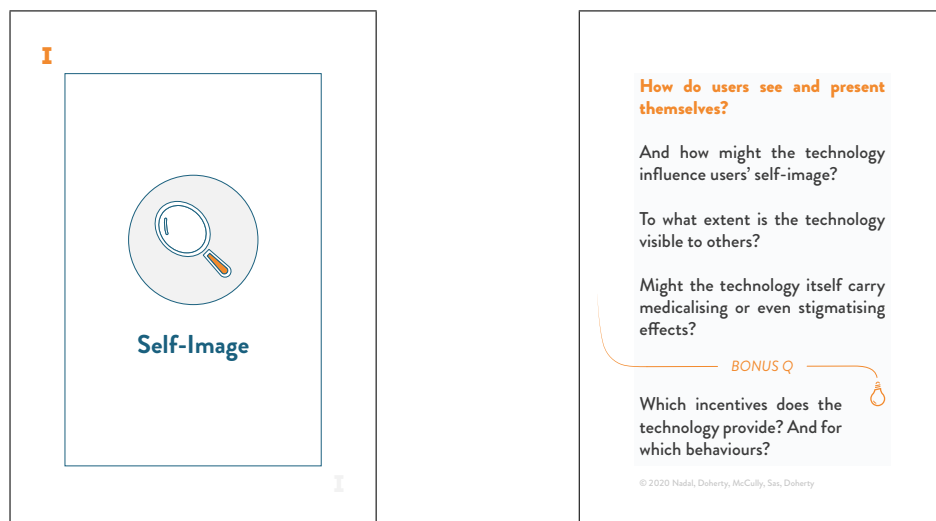


Figure A.4: Card for the factor *self-image* (front and back).

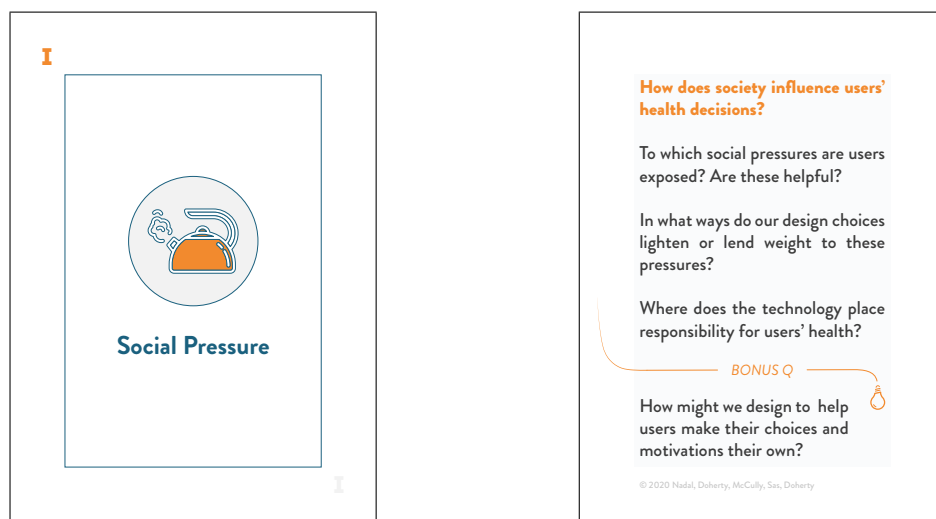


Figure A.5: Card for the factor *social pressure* (front and back).

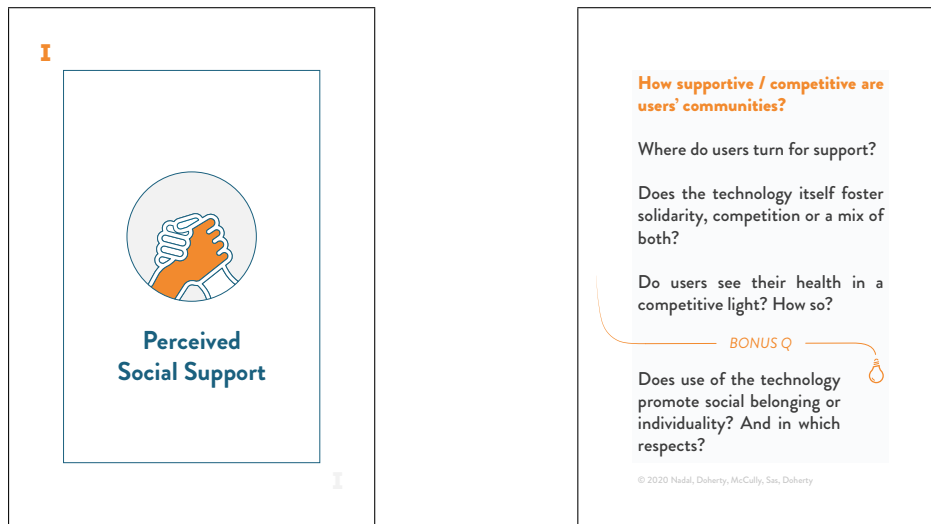


Figure A.6: Card for the factor *perceived social support* (front and back).

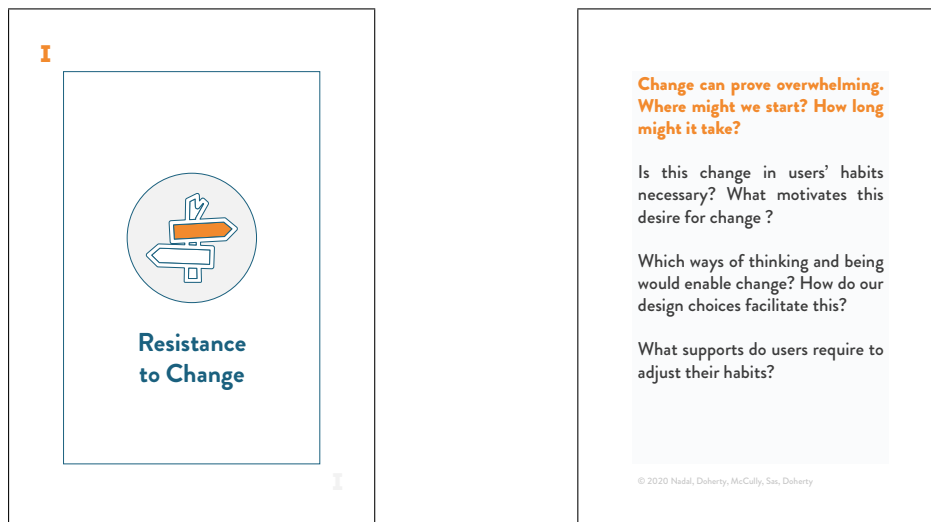


Figure A.7: Card for the factor *resistance to change* (front and back).

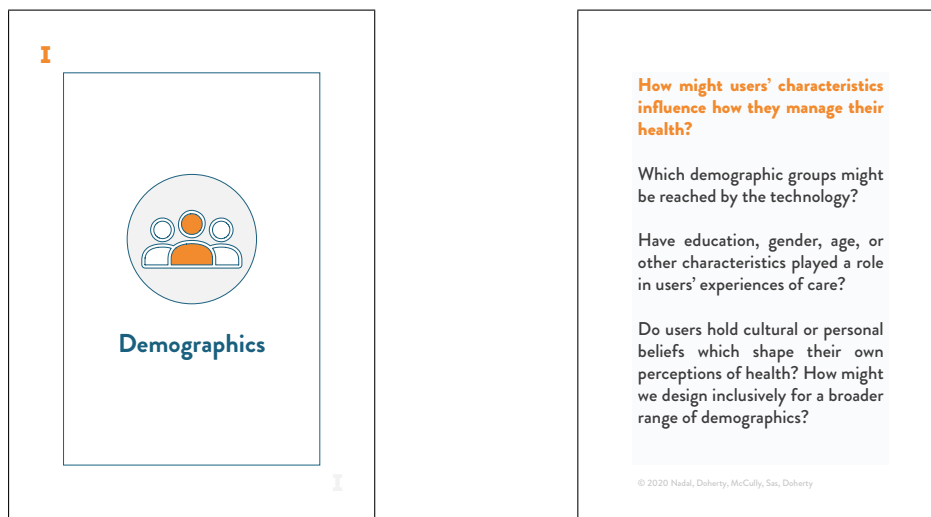


Figure A.8: Card for the factor *demographics* (front and back).

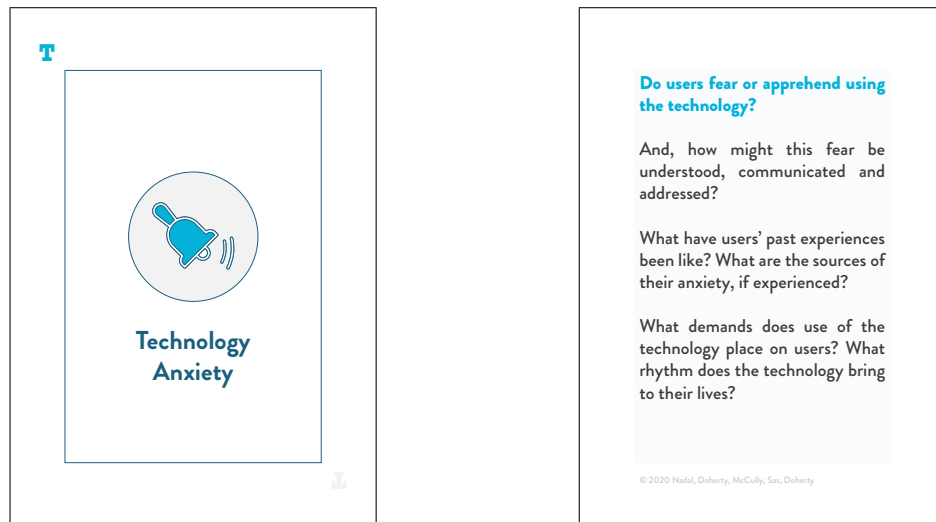


Figure A.9: Card for the factor *technology anxiety* (front and back).

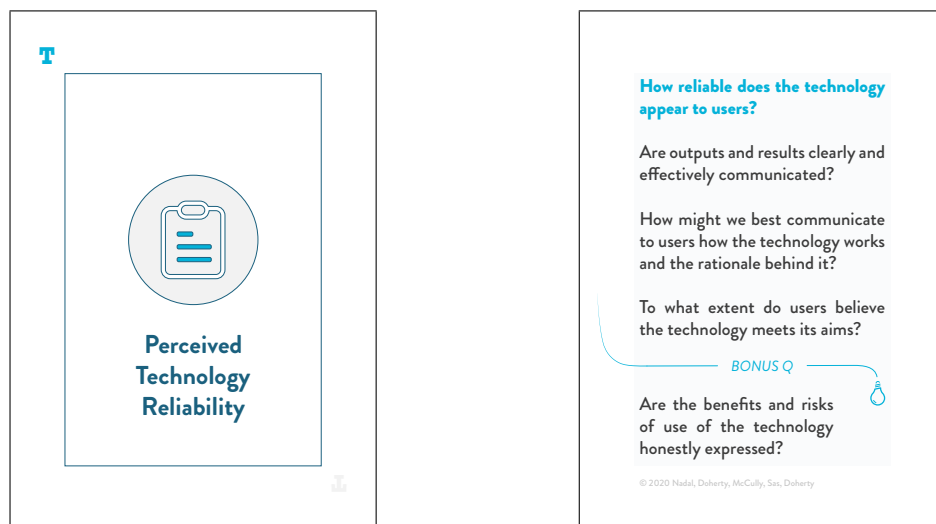


Figure A.10: Card for the factor *perceived technology reliability* (front and back).

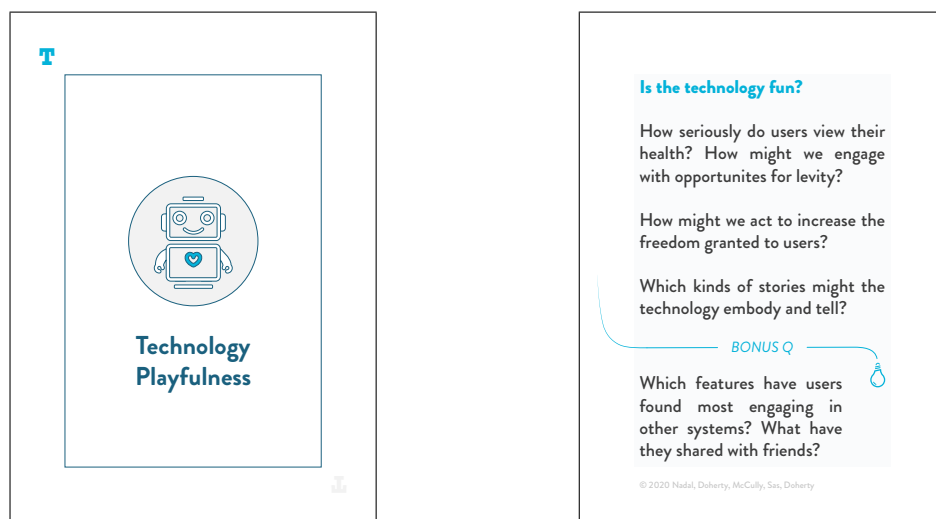


Figure A.11: Card for the factor *technology playfulness* (front and back).

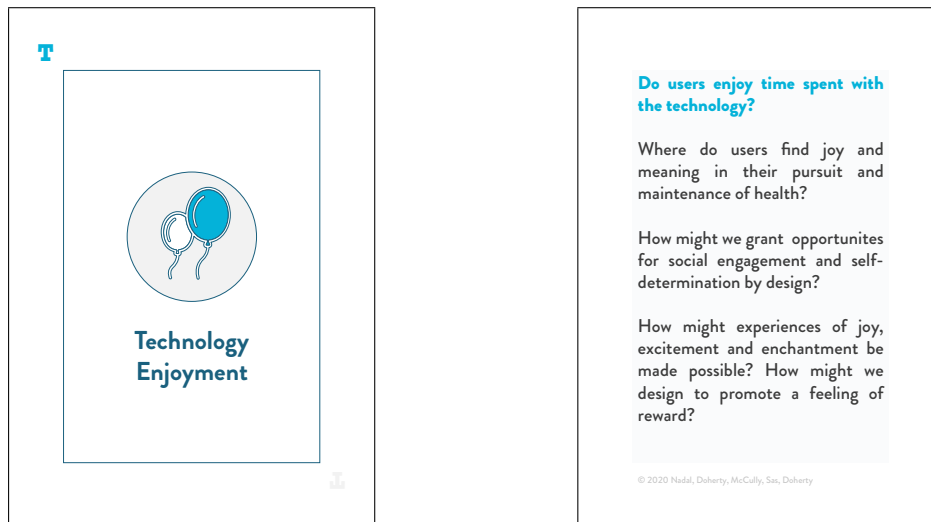


Figure A.12: Card for the factor *technology enjoyment* (front and back).

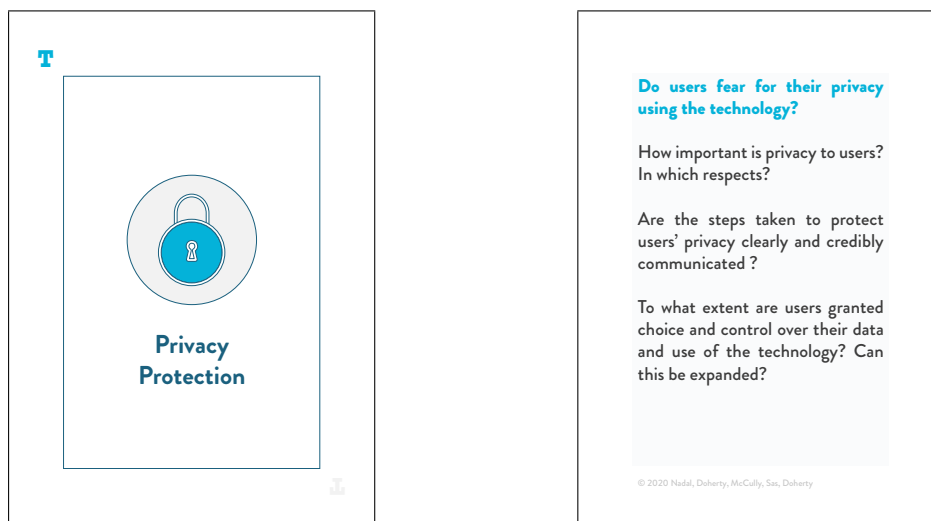


Figure A.13: Card for the factor *privacy protection* (front and back).

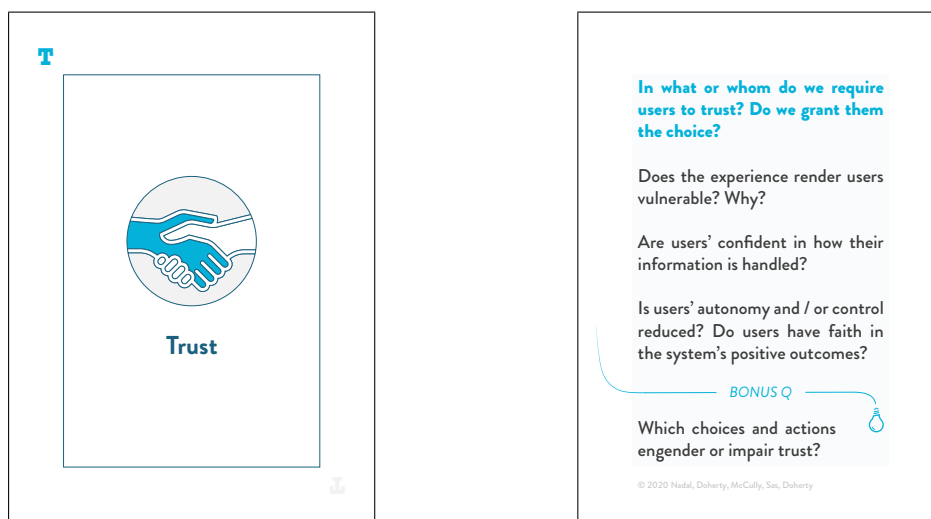


Figure A.14: Card for the factor *trust* (front and back).

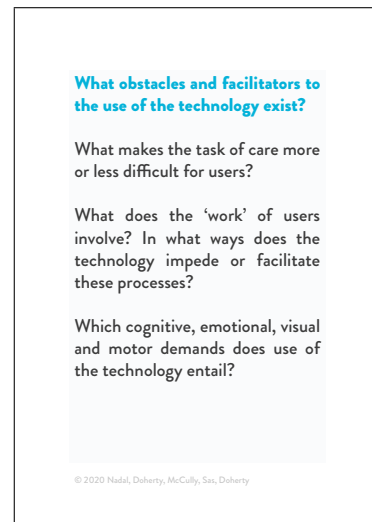


Figure A.15: Card for the factor *objective usability* (front and back).

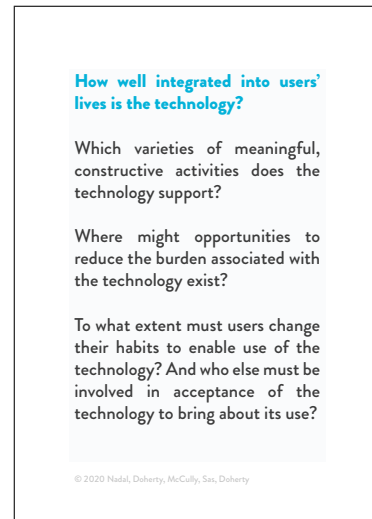
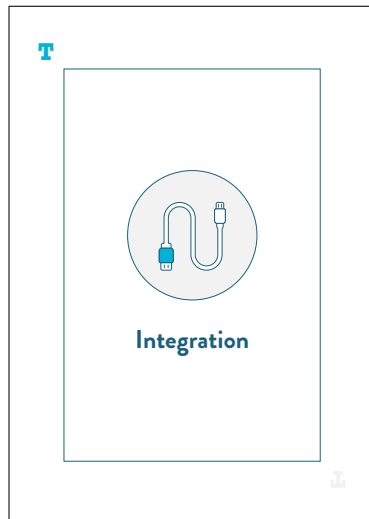


Figure A.16: Card for the factor *integration* (front and back).

Chapter B

TAC Personas and Scenarios

B.1 Ali, Depression



I am a happily retired florist. I have lived alone since my wife passed away. I enjoy my home and taking care of my garden, but sometimes the days are a bit lonely.



I have arthritis & I take medications for issues with my blood pressure but what worries me most is my mental state. My mental health hasn't been great these last few years, I opened up to my doctor & my daughter about the situation around 6 months ago after a particularly bad episode. I'm on antidepressants & I'm in a much better place now but my daughter often worries.



My only daughter lives abroad. She calls me every Sunday on Facetime and we tell each other about our week. I am also a member of the local senior club. I go three times a week and enjoy playing games with my friends.



Once, I tried to schedule a reminder for medication on my phone. I just couldn't get it to work. I suppose I am not good with new technologies.

Figure B.1: Persona Ali (Depression).

Ali (introduction): « *I have lived alone since my partner passed. I have a good group of friends and my adult daughter is very good to check in on me but sometimes it's all a bit much. I have a few different medical conditions, and as such, a few different medications to manage. My depression hasn't helped in keeping me on track with them. I need a change.* »

Nodes	Neutral path #1	Neutral path #2
SEEKING ADVICE	My daughter keeps asking me to get it. My daughter is always asking me if I've remembered to take my medication. She worries. She tells me about an app I can get that will take all the work out of it for me. We've had this talk before & although she means well, I get frustrated. She forgets I managed to raise her alright! I suppose it would take some worries off both of our hands though - I ask her for more information.	My friend swears by it. My friend at the senior club shows me an app his niece set up on his phone to remind him to take his heart medication. I'm not really good at the whole technology thing, the screen is too small & they're confusing. I can never get them to work how I want - or at all sometimes. I could do it with some help though, I get confused - which day, which pill. I ask my friend for more information.
CHOOSING TECHNOLOGY	I was chatting with my GP. My doctor has been great in these last few years, always concerned with my wellbeing. I had an appointment yesterday & they asked me how I'm doing, is there anything I need help with etc. I mention that I struggle with all the medications sometimes & how I've heard there's something I can set up on my phone. They tell me about this app, some of their patients use it, supposedly super helpful. Before I could complain about not being good with technology, they insisted on helping me download it & set it up.	She walked me through it over FaceTime. I am hesitant about having to download and set up some app things when I could just use my old system - I mean it says what days on the pill bottles, it's not rocket science. I know it's more hassle than it's worth though, this could be easier. My daughter facetimes me and has already done the research. She makes it easy, walks me through downloading and helps me set it up over the phone.
	 High severity path	 Medium severity path
FIRST INTERACTION	We need to change some things. It's all set up, all my medications are in but it took me a while. The text on my phone is too small. I mention this to my daughter and she tells me the text size can be changed, says something about settings this & change that. My daughter says if I can't find it we can do it over a call. I tell her I'll be fine, I'll fix it tomorrow. I'm slightly annoyed but at least it's set up now.	It didn't make me feel great. It's set up but it all seems over complicated. I know it seems silly but having to put it all in like that, each drug, each dose, each time - didn't make me feel great about my conditions. It was a bit overwhelming. I might have missed a dose or two with pen & paper but it never made me feel bad.
NEXT DAY	I don't want my phone buzzing all day. The notifications are coming in half an hour early, telling me to take my 10.30 at 10.00 etc. It's not a massive deal but it's annoying. I look into it and somewhere in the set up I think I have it so that it reminds me early - but I'm not sure how to change it. I know I can just add another reminder but if I do that for all of my medication my phone will be buzzing all day. A little annoyed, I'll ask someone about it.	My notifications need to be on. I went about my day as normal, took all medications as advised. I played tennis, went for lunch. It was a good day. It wasn't until my daughter called in the evening and asked me how I was getting on with the app that I realized - "This thing hasn't gone off once!" My daughter said something about notifications possibly being turned OFF. Technology never just works does it? I followed her instructions and later that evening, just as I was taking my 8pm dose - *bing* - a reminder to take that pill. Relieved!
A WEEK LATER	It's interrupting my sleep. It works, kind of anyway. Some of the alert times are wrong and I haven't been able to change the text size. All of this is apparently in settings but I'm sick of squinting at this thing trying to fix it. It works, but it's far from perfect. It's woken me up a few times when I'm drifting off to sleep which I hate, I struggle to get back to sleep and find myself staring at nothing on the phone for a bit. Mood isn't great the next day.	My second layer of defence. It works, kind of anyway. Some of the times are wrong and I don't always see the notification because I don't always have my phone but it works almost like a second layer of defence - If I have forgotten to take a dose I'll realise when I check my phone and can usually act quick enough.
AFTER A MONTH	It stopped reminding me. The app had been working great but the other evening something popped up on screen about an "Update". I didn't really know what it was, clicked okay, and ever since my alerts don't pop up. My notifications are ON, the alerts are still there when I go into the app but nothing shows up. There's been a change in some medications recently too. So, it's back to the old fashioned way.	I just didn't feel like charging my phone. I had a rough couple of days, I skipped the senior club the other night. I didn't feel up to it & the next day I couldn't even find the energy to get out into the garden. Last night I was feeling drained & a little sorry for myself so I decided to go to bed early. I didn't bother to plug my phone in. When I woke up I had several missed calls, I'd forgotten that when I set up the app I put my daughter in as an emergency contact and she gets a notification if I haven't responded to the reminder. Now, it was only my evening tablet, no big deal, but my daughter was sick with worry all night trying to get through to me! She was annoyed but so was I, we had an argument all day because I didn't charge my phone.
AFTER 3 MONTHS	I slipped up. I ended up taking the wrong pill the other day! I struggle to read the little messages sometimes and I got mixed up. The one I did take was meant to be taken two hours earlier but I had missed the notification! It wasn't a big deal this time - although my doctor wasn't happy - It has made me think twice about relying too much on this app.	It says I'm doing all the right things. The app gives me little "rewards" if I stick to & log my treatment for a few days in a row; a little gold badge with the words "Well Done", "Way To Go All" or something like that. Sometimes I do forget to log them in the app, but honestly I don't think I've missed a dose in months. I'm doing what I'm meant to do in order to be "healthy", but I don't feel healthy. I think the medication is affecting my appetite & I'm much less motivated to cook well for myself now I live alone. The "Well Done"s feel empty.
AFTER A YEAR	I take each day as it comes. I took my medicine today, same as everyday, and logged it in the app, same as everyday. My screensaver is my late wife. My mental health really only started to deteriorate after her passing, every time I swallow that antidepressant I always think about her & wonder how I got here. I take these pills every day, I log it here for my doctor & my daughter, I keep going, I take each day as it comes & I try to do my best but it's overwhelming sometimes. It should be my wife I see first thing in the morning, not a notification.	I visited my doctor. I saw my doctor yesterday for a check up. A few minutes into the appointment the doctor started asking, with a hint of suspicion, if I've been taking my medication. I ask what the problem is & they turn their monitor around to show me their "Clinical Dashboard" - the doctors' view of my medication app. "On this date you didn't log anything, the week beforehand you missed two days, and if we look at last month you missed 7 days total..." I was livid. I've managed my medication without the app & I don't need to be getting scolded by my doctor just because I don't always log my pills in some app - I'm busy! The app doesn't need to know everything, it's there to remind me not control me. I was looking after myself long before these "clinical dashboards" came along & I won't be dictated to by it.

Figure B.2: Scenario for persona Ali (Part 1).

Nodes	Neutral path #3
SEEKING ADVICE	I need some help. I sometimes find it difficult to manage all these medications - which pill, which day, what time, before a meal, after a meal - oh it's all a bit too much. My daughter got me a smartphone a few years ago, sometimes it's more trouble than it's worth, but I know there's a way this thing can help me with my situation...
CHOOSING TECHNOLOGY	I read all the reviews. I know my phone is capable of doing this - they're capable of doing loads of things & all I want is - essentially - a set of alarms. I do some research on the desktop - easier to read - and apparently there's multiple options for medication management. I flick through some reviews and find the most positively rated one. I go back to my phone & download it.
	 Low severity path
FIRST INTERACTION	I'm all set up. All seems simple enough. There's a big "+" at the top, I can add my medication there, details on what time I need to take them, even a little message to go along with the alert. Setting up all my medications takes a little time but I think I'm good to go now. Looking forward to seeing if this works.
NEXT DAY	It's good but it's vague. The reminder popped up telling me to take my 9.30am pill - which was good, I had the bottle on the table - but I noticed: the reminder didn't say which pill I had to take, just reminded me of my dose time. Maybe it's for me, like a security thing so no one looking at my phone will know what I'm taking. Not that it matters to me. But still, I have quite a few medications, this could be an issue.
A WEEK LATER	More helpful than I imagined. It's been working like a charm. I haven't missed a single dose this week and it has been more helpful than I initially imagined. It took a day or two to get used to it, fix some little things, but it's very handy.
AFTER A MONTH	I was showing it to everyone. The app has been great. A reminder popped up one evening while I was at the senior club, a few of my friends were asking me all about it. It was so nice to be the "tech savvy" one for once. My friend had been recommending it to me for so long and he knows I struggle mentally sometimes, so he is happy to see me doing well.
AFTER 3 MONTHS	The phone has been a lifeline. It hasn't been easy to see people recently. My life at the moment is my home, my garden and my phone. My GP & daughter have been checking in more often which is nice. When I first got this phone I didn't like it but since I've started having to track my medicine, I've been getting much better at using it - it's not as daunting anymore. I am now able to get the news, listen to the radio, track my medicine, even see & talk to my family, it's great. I see my daughter more now than I did a year ago. Without it I would be so much more isolated.
AFTER A YEAR	My schedule is like clockwork now. The app has been good & it certainly works. I can't remember the last time I forgot to take one of my pills. I am so used to my schedule now that I barely even need the notifications.

Figure B.3: Scenario for persona Ali (Part 2).

B.2 Ella, Diabetes

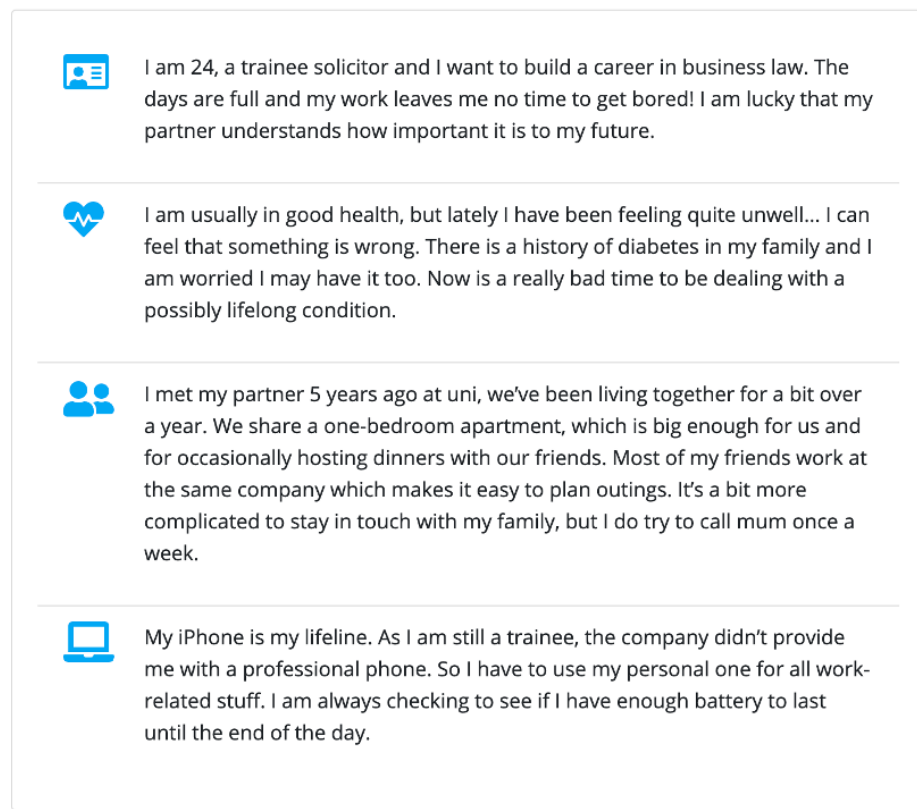


Figure B.4: Persona Ella (Diabetes).

Ella (introduction): « *I have not been feeling great lately. I cannot seem to quench my thirst no matter how much I drink, my diet hasn't changed but I seem to be losing weight, I have to go to the bathroom all the time, and last week, I went light headed while on the bus, couldn't see properly and it gave me quite the scare. The test results came back the other day & just as I feared, type 2 Diabetes. This is all really new to me and a bit scary to be honest. Now I have an underlying condition, all of a sudden I'm "sick" all of the time.* »

Nodes	Neutral path #1	Neutral path #2
SEEKING ADVICE	I just saw my doctor. I know it's more than manageable in this day and age but it's really daunting. I'll have to constantly monitor my blood sugar, what - and how much - I eat and drink. It's good to get a diagnosis but still... My doctor has recommended the "Dexcom Continuous Glucose Monitoring system". It's a small sensor I put just under my skin that sends information about my blood sugar & stuff to an app on my phone.	So, I was chatting to. I have an aunt who has had diabetes for as long as I can remember. As soon as I got my diagnosis I gave her a call. I remember watching her pricking her finger to get blood sugar readings, having to avoid desserts and sweets. I tell her I'm feeling a bit overwhelmed but she maintains it's not like it used to be - "Oh, there's an app for all that day to day stuff dear" - apparently they're called "glucose management systems". She tells me not to be too worried and sends me the details.
CHOOSING TECHNOLOGY	My mom thinks. My mom works in healthcare & has been really helpful throughout this, I was telling her how much I am struggling with the daily management. She asks around in work, and apparently most people use these "Glucose monitoring systems", a colleague of hers recommends the Dexcom. Willing to try anything at this stage.	So, I was chatting to. My friend went through something similar a few years ago & I ask them how they manage it all. "I haven't used a pen & paper diary in years" they tell me. "Get yourself a Dexcom, honestly it takes all the work out of it. How often have you seen me stress about my blood sugar? Exactly, never." They sent me the details and I'm feeling hopeful.
	 High severity path	 Medium severity path
FIRST INTERACTION	I don't think this is working. The instructions say to pair the sensor with the app on my phone before inserting it, but I think the sensor might be broken. The sensor isn't showing up as an option to pair with in my bluetooth settings. Maybe it's an issue with my phone but I'm not sure.	It's all paired up but I didn't think of this. I'm a bit cautious about the bluetooth - isn't that going to be a big drain on my battery? Will I need a battery pack? Plus, I'm sure I've heard things about bluetooth being a security weak point, is this something I need to worry about?
NEXT DAY	I forgot to charge my phone. My phone died during the middle of the night & by the time I remembered to charge it in the morning, I had an alert about my low blood sugar!	I struggled to get to sleep last night. Seems to be working fine but it feels really weird having the sensor attached to my stomach at all times. I was just drifting off when I turned over, I could feel the sensor poking into me a bit. It wasn't sore but definitely a distraction. I was worried that sleeping on it would affect my readings & I just couldn't get comfortable.
A WEEK LATER	My readings don't seem right. Every morning I get a notification about my blood sugar being "dangerously" low. I would expect it to be on the lower side in the morning, having not eaten for 8 hours, but not this much. I obviously check it the traditional way and - of course - I'm where I expect to be. I've been following the diet so I knew I couldn't be that bad but still, a scary notification to start your day with. Maybe it's because I sleep on my stomach, maybe it's just a bug or something. I'm not sure.	My battery keeps dying. A full charge at night used to last me all day but my phone has been dying earlier since I started using the Dexcom. It's not an issue at work as I can just charge it at my desk. But the other day, we were out with clients and I had to scramble to find a plug, I wasn't sure if I remembered a charger, oh it was all a bit stressful to be honest. So I bought a powerbank today - one of those external battery things - for some peace of mind.
AFTER A MONTH	I need to change the sensor. The physical sensor on my stomach has to be changed every 10 days. It only takes a minute and it's not a big deal, but after I changed it a few days ago it doesn't seem to be working right. As usual, when I change the sensor I calibrate it in the app against a traditional blood sugar reading but within a half hour it said my sugars were trending downwards even though I'd just eaten. I thought it might fix itself but my numbers have been all over the place and I'm a bit worried. Hopefully it's just a faulty sensor.	Anytime I bathe. It's been working great but I'm not too sure about how "waterproof" the device actually is! If I have a bath it takes about an hour or so to start giving me accurate measurements again! Other people online seem to be having the same issue. Maybe it's the temperature, I'm not sure. I'll stick to showers from now on.
AFTER 3 MONTHS	My sensor nearly came off again. It's okay - the measurements weren't always accurate & it's a massive drain on my phone battery - but it works, kind of. What's most annoying about it is that sensor. I keep nearly ripping the thing off when getting changed. I'm looking into other options.	Back to pen and paper. I'm having major issues with the nighttime readings. I've seen online that sleeping on your stomach can cause some issues, and to be honest sometimes I forget to charge my phone when I go to bed. It's good but it brings its own issues. It's a hassle. I've started tracking manually again, I'm not sure if I need it but I'm going to talk to my doctor about other options.
AFTER A YEAR	Back to the drawing board. I just couldn't trust it after a while. Some sensors just wouldn't work, some were giving inaccurate measurement and some worked. Just unreliable. Plus, it was a massive drain on my battery & I hated carrying around that powerbank. It was meant to relieve some of the stress but it just brought its own. Looking into other options.	I just have to be mindful at night. It's been such a great addition! Of course it's not perfect, I don't fully trust its nighttime measurements & I have to be conscious of my phone battery all the time but I've learned to account for all of that in my daily management. All in all, the pros definitely outweigh the cons.

Figure B.5: Scenario for persona Ella (Part 1).

Nodes	Neutral path #3
SEEKING ADVICE	I need to do some research. Now I have to watch what I eat constantly, watch my fluid intake, I have to prick my finger to get my blood sugar & I have to keep a record of all those readings. My doctor recommends keeping a diary. It's time consuming to be honest and a bit of a mental drain. Surely, in this day & age there's an app for this? I do some research.
CHOOSING TECHNOLOGY	I keep seeing this Ad. I don't know if it's because I've been talking about it more or maybe it's because of recent online searches but all of a sudden I'm getting loads of ads in my feeds for Diabetes related stuff. I saw this ad for the Dexcom Glucose Monitoring System - it's a little sensor that goes on my stomach & it sends the relevant info to an app on my phone. The reviews are good & it sounds so helpful - "Always know your glucose number" with "zero fingersticks and no calibration". Sounds too good to be true to be honest, but I do some research & it seems "legit". I buy it.
FIRST INTERACTION	 Low severity path Oh, I didn't know it could do that. Setting it all up was easier than I expected. The sensor is attached to my stomach, just above my hip. It's a bit weird but it's discrete. I'll get used to it. The app seems to have a lot more to it than I initially imagined - I can connect it to my fitbit so it takes into account my workouts.
NEXT DAY	I was measuring my blood sugar. I was curious to see how accurate the measurements were & how fast they updated, so about 10 minutes after breakfast I got a reading via the "finger prick"/traditional method and checked it against the app. It was correct, which is such a relief! I can see what direction my blood sugar is trending in which will be so helpful when making food choices. I've been eating a lot better since the diagnosis so it's great to see that represented in the data.
A WEEK LATER	I'll share my data with you. There's a feature in the app whereby I can share my health data with someone in my contacts - this has been great because my partner worries & they were much less trusting of the system initially. It's taken a lot of weight off both of our shoulders to be honest.
AFTER A MONTH	I set up customized alerts. It has been a lifesaver to be honest! It's made daily management so easy! I just discovered that I can set up my alerts so that it doesn't just let me know when I'm too high or too low, but also when I'm in a certain range. The trends kind-of already give you this info but I have to consciously decide to check those. With these I don't have to be reactive to my blood sugar, I can be proactive. I feel like I have so much more control now.
AFTER 3 MONTHS	Out for a swim. It's been great! I went swimming with friends the other day - when I first got it I was a bit self-conscious about the sensor - but I'm so used to it now. They were asking questions about it, not in a rude way, they were really interested actually. Felt like I had some cool exclusive health gadget that they couldn't get. It feels like a part of me. It's been great. I have my readings at hand, I have my data saved over time, it's linked with my fitbit & my partner has access. It's been so helpful in adjusting to the diagnosis. It just feels like part of my routine now, like a part of me having diabetes. Like a part of me I suppose. I would definitely recommend it.
AFTER A YEAR	It feels like a part of me. It's been great. I have my readings at hand, I have my data saved over time, it's linked with my fitbit & my partner has access. It's been so helpful in adjusting to the diagnosis. It just feels like part of my routine now, like a part of me having diabetes. Like a part of me I suppose. I would definitely recommend it.

Figure B.6: Scenario for persona Ella (Part 2).

B.3 Alex, COVID-19

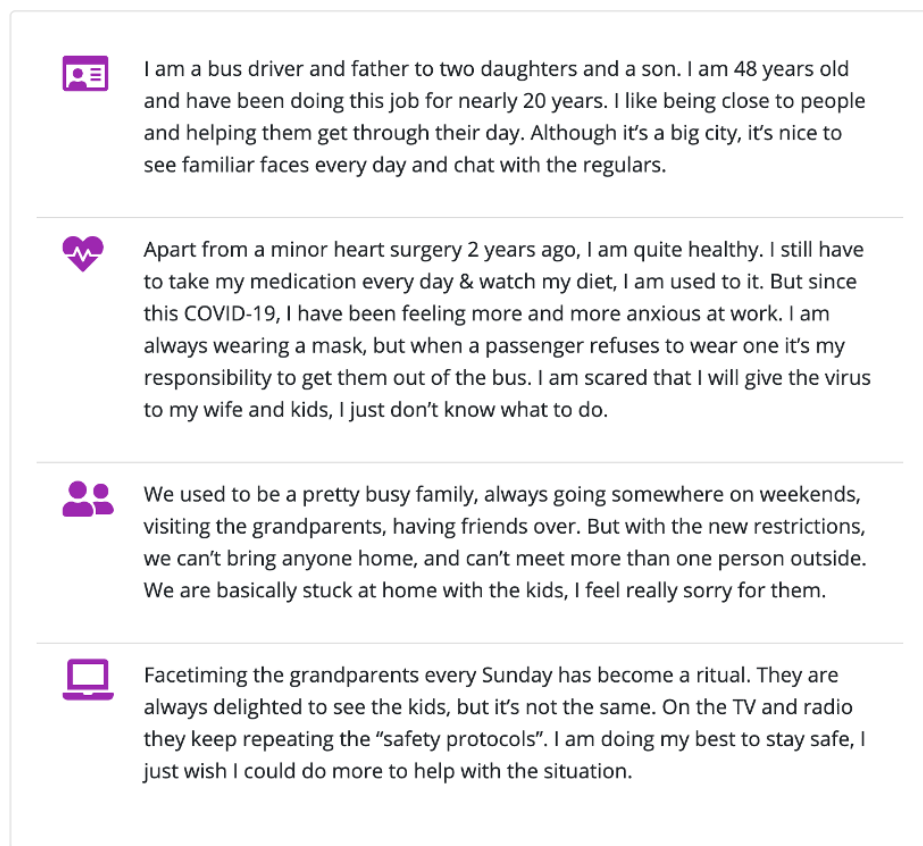


Figure B.7: Persona Alex (COVID-19).

Ella (introduction): « *COVID-19 has obviously become a big issue. There's been thousands of cases in our country, they keep going up & the roll out of the vaccine will take a long time! I'm quite worried as I work with the public and I did have a major heart surgery a few years ago. I'm not sure if my body could handle it if I was to get it. We're going to have to live with this but I'm not sure how.* »

Nodes	Neutral path #1	Neutral path #2
SEEKING ADVICE	We were watching the news when. The Minister for Health was on the news explaining how important “contact tracing” app is in terms of dealing with this whole COVID thing. They were talking about how important this is for us to download it, how it's fully GDPR compliant, we can opt out whenever etc etc. Seems important.	I talked to the family. We were having dinner, chatting & once again COVID was the topic of conversation. They're worried about me coming into contact with it working the bus route, and to be honest, so am I - especially with my heart. My son asks if I have downloaded the contact tracing app. I mention I have some hesitations, privacy and all that, but he walks me through it.
CHOOSING TECHNOLOGY	There it was, in the AppStore. When I logged on to Twitter this morning the first Ad in my feed was from the government, for this contact tracing app. I was going to download it anyway, but decided to click in straight away and get it downloaded before I forgot.	It was on the boss's orders. We all got an email in work from the head office. They have insisted we download the COVID tracker app if we want to stay on the job. I would have probably done it anyway but still, the role is public facing & public sector so I can see why. Went onto the App Store and downloaded it.
	 High severity path	 Medium severity path
FIRST INTERACTION	Is this thing working? Downloaded it from the App Store but it doesn't seem to be right. It downloaded fine but when I try to open it I get some warning about “device compatibility”. I haven't gotten a new phone in a few years, I think I might have to upgrade.	I've heard it's a big drain. Downloaded it from the App Store, all it needed was my phone number to set up. It requires bluetooth to be on - all the time. I'm a bit worried about it draining my battery if it's on all day.
NEXT DAY	I'm lost in the settings. I thought I had it set up correctly but after talking to a friend at work about it, I realised I didn't “opt-in” for the contact tracing. I'm a bit lost in the settings to be honest, but I think I have it turned on now.	My battery seems low. I “checked in” this morning before work. No symptoms obviously. I charge my phone overnight and it generally lasts me all the next day, but my battery was at 20% by lunch today. It must be the tracker app, I've heard it's a big drain.
A WEEK LATER	I was really worried when I saw the notification. I got an “exposure notification” yesterday. Apparently I had been in close contact with someone who tested positive - the only thing is, I've been off work the last two days, I haven't left the house I was thinking maybe it was a family member but none of them have gotten the same notification. I have no symptoms but I called my doctor regardless. Not too confident in the app at the moment.	I think I need a new phone. I bought a new phone. My old one wasn't compatible and now is as good a time as any to upgrade I suppose. The app is set up on my new phone & seems to be working fine. I check in once a day & haven't gotten any notifications.
AFTER A MONTH	I got tested. Initially I thought I was overreacting, slight cough, bit of a headache etc. But as soon as my taste & smell started to go I knew something was wrong. Thankfully I had been off work. Got tested 3 days ago & have been quarantined ever since. The doctor asked me if I had the app & then asked if they could put in a code to notify close contacts. I said yes, it was the least of my concerns. Quarantined in the spare room, slightly worried.	I picked up a power bank. I had to buy a power bank for my phone. Having my bluetooth on all day was draining my battery too much. It's quite annoying & clunky.
AFTER 3 MONTHS	It keeps crashing for me. I don't know if it's my phone or the app but it crashes everytime I try to check in. I've kept the app because it has up-to-date information about the number of cases in the country but I'm not sure how much good I'm doing by having it if it doesn't work as intended.	I haven't thought of it much. I've forgotten about it to be honest. It's useful for the case data but that's on the news most evenings & I don't know how much I need to hear daily cases if we just have to live with this COVID situation. It's overwhelming. I don't usually check in but I keep the app just in case I get a close contact notification.
AFTER A YEAR	I don't think I need it. We haven't had a community transmission in 6 months. The threat is still there but life has returned to normal - more or less. I got a new phone a few months ago & didn't bother to download the contact tracing app.	It's no hassle to keep it. I kept the app on my phone & checked in every day for a while, gradually less & less, and now I don't use it at all to be honest but things are a lot more under control at the moment. We haven't had a community transmission in 6 months, the threat is still there but life goes on. Still hesitant with regards to sharing my location constantly but it's a small price to pay considering the national risk.

Figure B.8: Scenario for persona Alex (Part 1).

Nodes	Neutral path #3
SEEKING ADVICE	I was on the internet. I've seen a lot people talking about this "contact tracing" app on Twitter in the past few days, not all positive. There's been a bit of chat in my WhatsApp groups about it - which is far from peer-reviewed I know - but still, I've got some apprehensions about it. The health minister tweeted a series of videos explaining how important contact tracing was to the public effort.
CHOOSING TECHNOLOGY	We were chatting over dinner. COVID has been the main topic of conversation at our dinner table lately. I ask my son about this contact tracing app, tell him some of my hesitations - what I've been seeing in my WhatsApp chat. He's a bit more turned into this tech stuff. Says it's WhatsApp I should be worried about, not the contact tracing app - especially with my condition. He walks me through it a bit more, even downloads it for me.
	 Low severity path
FIRST INTERACTION	Well, that was easy. Downloaded it from the App Store, seemed simple enough. It needs my number & my location. It has all the information about the country's cases, regional case breakdown etc. I had to "opt-in" for the contact tracing feature so that I'll get a notification if I'm near a confirmed case. Still somewhat hesitant, privacy wise, but given the situation, I think this is more important.
NEXT DAY	It only takes me seconds. Checked in this morning and that was it really. Over and done with in a few taps. It has information about the country's cases & stuff but other than that, there's not much to it.
A WEEK LATER	I use it once a day and then forget about it. I check in once a day & haven't gotten any notifications. It doesn't bother me & I've been encouraging those around me to download it.
AFTER A MONTH	I barely notice it. It's routine now, I check in over breakfast each morning, close the app & forget about it. Haven't gotten a single notification.
AFTER 3 MONTHS	I got a worrying notification. I got a notification last week that I had been in close contact with someone who tested positive. Given my work on public transport, it's not surprising. It was quite worrying to be honest. I thought "if I have it, then the rest of the family do as well, not to mention everyone at work". I would hate to be the one to have given it to family & friends. Everyone at home felt fine but we got tested regardless. Negative thankfully, but those were a stressful few days regardless!
AFTER A YEAR	I'm glad I used it. I'm glad I downloaded it to be honest! The family had a couple of scares where we got close contact notifications and had to get tested. Having the case numbers was handy but probably a bit too much information at times. Thankfully we've all managed to stay healthy.

Figure B.9: Scenario for persona Alex (Part 2).

Chapter C

TAC Interview Guide

Thanks again for your participation in the workshop. This is the final interview; I am going to ask you questions about your experience in the workshop. It will last about 30 minutes. In the extremely unlikely event that illicit activity is reported I will be obliged to report it to appropriate authorities. You may withdraw from this interview at any moment without consequences, simply let me know. Are you happy to start the interview now?

OPENING QUESTIONS

1. **Can you tell me a little about yourself?** *In which health context do you work? What is your role? What kinds of technologies do you work with? Have you thought about health technology acceptance before?*
2. **Have you ever considered the issue of user acceptance in your work?** *Can you think of an example where you were concerned about a user acceptance issue?*

THE TAC CARDS

3. **Can you describe your experience working with the TAC cards to me?** *How did you find it? How was this different to how you might approach design normally? Did this change how you thought about the issue of acceptance? Is there anything you would do differently?*
4. **How did the TAC Cards impact your perception of the user, as reflected in the persona and scenario?** *Did they shape your way of thinking about the user in any way? How did they impact your understanding of the user? Do you feel that the cards impacted how you felt about the user?*
5. **In what way did the TAC Cards impact your thinking around user acceptance of health technology?** *Did you learn anything new? Was there anything you had not thought about before? Was there anything that you felt was missing in this process?*

THE PERSONA & SCENARIO

6. **The scenario describes an individual user's experience over time. How did you find this shaped the design process?** *Did you find it useful to work with the user's evolving relationship to the technology over time? How did you feel about the different paths proposed in the storyline? Is there anything that you found particularly helpful? Is there anything that you found challenging?*
7. **How did you feel the persona and scenarios work with the TAC Cards?** *Did the persona and scenarios add value to the cards? Did they simplify or complicate your use of the cards? Would you change anything in the way that the persona and scenario were used?*

THE THINK-SPACE

8. **And what did you make of the Miro board itself?** *How well did you find it presented? Did it take you long to make sense of it? Was it easy to navigate? Did it support useful conversations? Would you change anything about its presentation?*
9. **What did you think of the combination of the different materials?** *If you were to employ the TAC Cards again, do you think you would use them with the Miro board? What did you make of using a virtual storyboard? Would you have preferred another format?*

THE ROLE-PLAY

10. **Were you a User or a Designer? How comfortable did you feel in this role?** *How helpful did you find the role-play? How did it impact the way you felt about the user? If you were to use the TAC Cards in your own work, would you employ the same kind of role-play?*

THE TAC CARDS IN PRACTICE

11. **Would you see yourself using (tools like) these cards in your own work? How might you go about doing so?** *In the context of which kinds of users and technology? When in the design process do you think they would be the most helpful? Would you see yourself using the cards during interaction with users? How so? What do you think would be the main benefits of integrating the TAC Cards into design practice? Do you think the cards would support design for vulnerable groups? Might they be used as an educational tool? What do you think would be the main challenges of integrating the TAC Cards into design practice? And in your own work more specifically? How do you think we could go about addressing these challenges?*

WORKSHOP

12. **How was your overall experience of the workshop?** *Was there anything you particularly liked or disliked, anything you found off-putting? Anything that made you realise something important?*
13. **Do you have any final thoughts you would like to share?**

Chapter D

TAC Final Think-Spaces

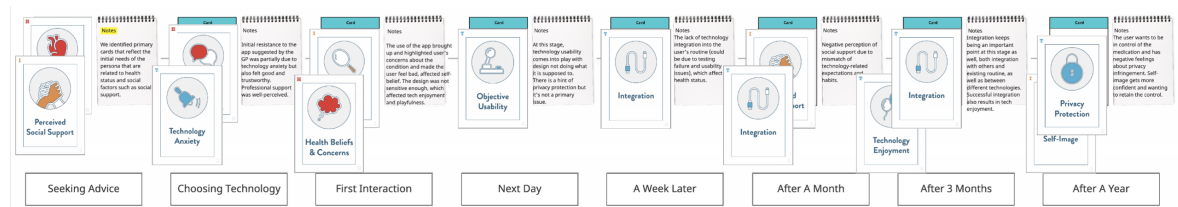


Figure D.1: Think-space used by Group 1, as it stands after the workshop.

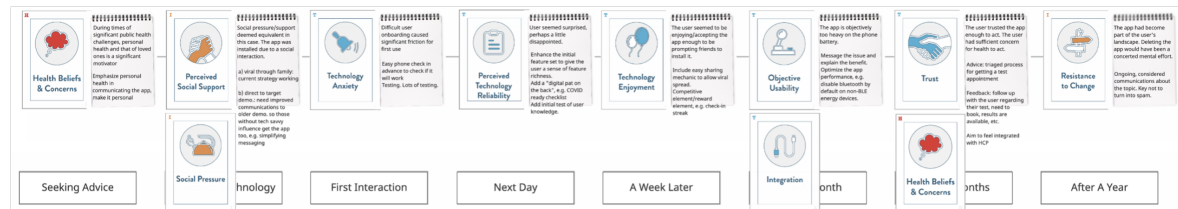


Figure D.2: Think-space used by Group 2, as it stands after the workshop.

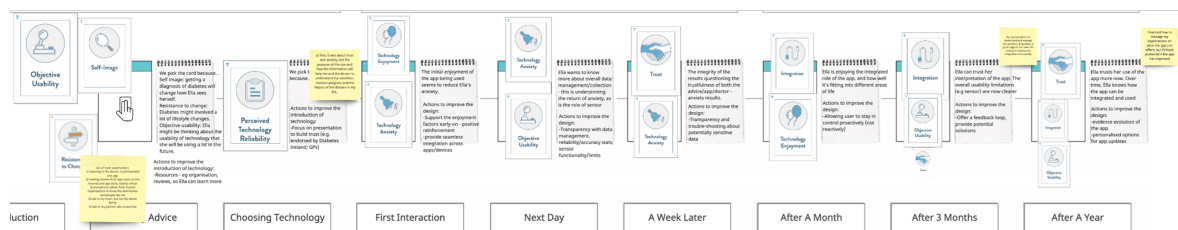


Figure D.3: Think-space used by Group 3, as it stands after the workshop.

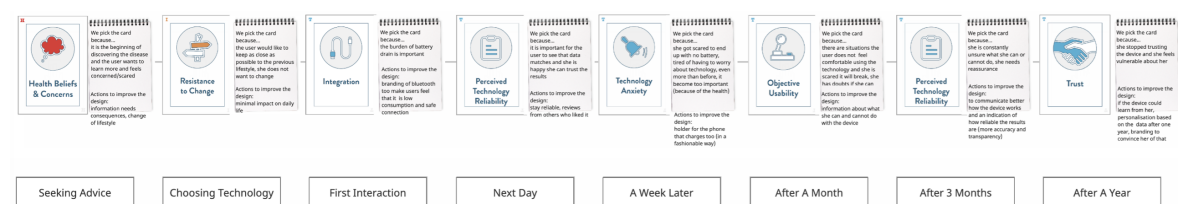


Figure D.4: Think-space used by Group 4, as it stands after the workshop.

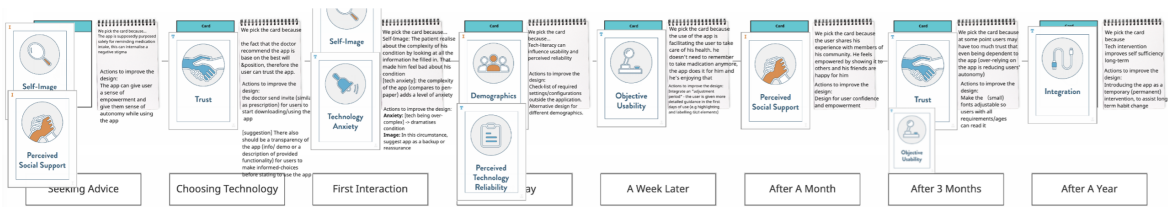


Figure D.5: Think-space used by Group 5, as it stands after the workshop.

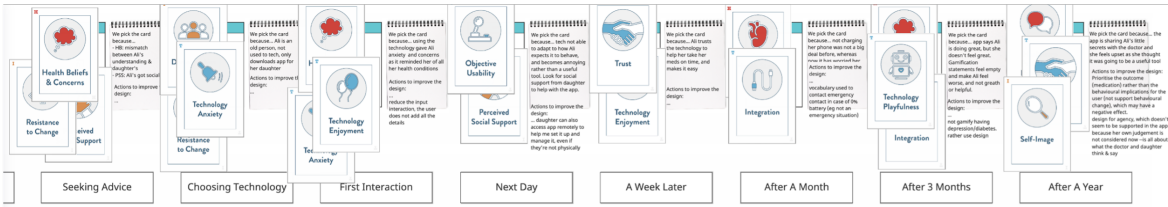


Figure D.6: Think-space used by Group 6, as it stands after the workshop.

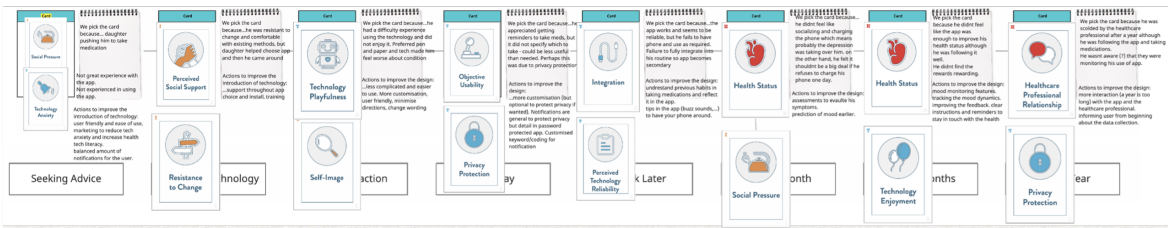


Figure D.7: Think-space used by Group 7, as it stands after the workshop.

Chapter E

TAC Thematic Analysis Summaries

Table E.1: Inductive thematic analysis themes.

Overarching themes	Themes
Bridging acceptance theory and design practice	Challenging designers' preconceptions about technology acceptance Extending designers' understanding of technology acceptance Motivating the application of acceptance theory through playfulness Supporting the negotiation of acceptance factors Shaping designers' practice to better account for acceptance Adopting a more ethical approach to design for acceptance
Fostering richer reflections on acceptance concepts and process	Facilitating reflection around acceptance Opening new perspectives through interdisciplinary collaboration
Supporting conversations	A common vocabulary of acceptance

Table E.2: Deductive thematic analysis themes.

Overarching themes	Themes
Understand the dynamic and evolving nature of user acceptance	Considering the question of acceptance throughout the user journey Negotiating the interplay among factors influencing acceptance Accounting for the variety of user trajectories when considering acceptance The difficulty of envisaging future acceptance issues

Chapter F

Versions of the Acceptance Questionnaire

Table F.1: Acceptance Questionnaire at 3 weeks (T2).

Constructs	Item codes	Measurement items	
		Smartwatch group	Treatment as Usual group
Perceived Health Threat	PHT1	I am strongly concerned about my mental wellbeing.	I am strongly concerned about my mental wellbeing.
	PHT2	I would make efforts to manage my mental wellbeing.	I would make efforts to manage my mental wellbeing.
Perceived Usefulness	PU1	I think that keeping track of my mood with the watch app is useful in managing my mental wellbeing.	I think that tracking my mood with the program is useful in managing my mental wellbeing.
	PU2	I think that keeping track of my sleep and physical activity automatically helps in managing my mental wellbeing.	I think that tracking my lifestyle choices, such as sleep and physical activity, with the program is useful in managing my mental wellbeing.
	PU3	Overall, I think that the watch app is useful in managing my mental wellbeing.	
Perceived Ease of Use	PEOU1	I think that it is easy to track my mood with the watch app.	I think that it is easy to track my mood with the program.
	PEOU2	I think that it is easy to track my sleep and physical activity with the watch app.	I think that it is easy to track my lifestyle choices with the program.
	PEOU3	My interaction with the watch app is clear and understandable.	
Attitude Toward Use	PEOU4	I think that the watch app is easy to use.	
	ATU1	I am comfortable recording my mood data with the watch app.	I am comfortable recording my mood data with the program.
	ATU2	I am comfortable recording my sleep and physical activity data with the watch app.	I am comfortable recording my lifestyle choices, such as sleep and physical activity, with the program.
	ATU3	I am comfortable sharing my mood data with my SilverCloud Health supporter.	I am comfortable sharing my Mood Monitor with my SilverCloud Health supporter.
Intention to Use	ATU4	I am comfortable sharing my sleep and physical activity data with my SilverCloud Health supporter.	I am comfortable sharing my Lifestyle Choices chart with my SilverCloud Health supporter.
	ITU1	I intend to use the watch app until completion of my treatment.	I intend to track my mood and lifestyle choices, such as sleep and physical activity, when prompted by the program until completion of my treatment.
Usage Behaviour	UB1	What difficulties (if any) did you experience while installing or using the watch app?	How would you describe your use of the Mood Monitor and Lifestyle Choices chart?
	UB2	How would you describe your use of the watch app?	

Table F.2: Acceptance Questionnaire at 8 weeks (T3).

Constructs	Item codes	Measurement items	
		Smartwatch group	Treatment as Usual group
Perceived Health Threat	PHT1	I am strongly concerned about my mental wellbeing.	I am strongly concerned about my mental wellbeing.
	PHT2	I would make efforts to manage my mental wellbeing.	I would make efforts to manage my mental wellbeing.
Perceived Usefulness	PU1	I think that keeping track of my mood helped in managing my mental wellbeing.	I think that tracking my mood with the program helped in managing my mental wellbeing.
	PU2	I think that keeping track of my sleep and activity automatically helped in managing my mental wellbeing.	I think that tracking my lifestyle choices, such as sleep and physical activity, with the program helped in managing my mental wellbeing.
	PU3	Overall, I think that the watch app was useful in managing my mental wellbeing.	
Perceived Ease of Use	PEOU1	I think that it was easy to track my mood with the watch app.	I think that it was easy to track my mood in the program.
	PEOU2	I think that it was easy to track my sleep and physical activity with the watch app.	I think that it was easy to track my lifestyle choices in the program.
	PEOU3	My interaction with the watch app was clear and understandable.	
	PEOU4	I think that the watch app was easy to use.	
Attitude Toward Use	ATU1	I was comfortable recording my mood with the watch app.	I was comfortable recording my mood data with the program.
	ATU2	I was comfortable recording my sleep and activity data with the watch app.	I was comfortable recording my lifestyle choices, such as sleep and physical activity, with the program.
	ATU3	I was comfortable sharing my mood data with my SilverCloud Health supporter.	I was comfortable sharing my Mood Monitor with my SilverCloud Health supporter.
	ATU4	I was comfortable sharing my sleep and activity data with my SilverCloud Health supporter.	I was comfortable sharing my Lifestyle Choices chart with my SilverCloud Health supporter.
Intention to Use	ITU1	I would use the watch app again if I felt the need to monitor my mood.	I would use the Mood Monitor again if I felt the need to monitor my mood.
	ITU2	I would use the watch app again if I felt the need to monitor my sleep and physical activity.	I would use the Lifestyle Choices chart again if I felt the need to monitor my sleep and physical activity.
Usage Behaviour	UB1	How would you describe your use of the watch app?	How would you describe your use of the Mood Monitor and Lifestyle Choices chart?

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