AGEING WITH TECHNOLOGY

An extended multimodal design study of
active ageing users' emotional experience with social robots

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برای مامان و بابا

To Mum and Dad

ABSTRACT

This research explores the experience of advanced technology for active ageing users through their extended engagement with a social robot as a subcategory of smart products. In this project, such influences include the capacity of technology to affect the social, behavioural and emotional aspects of users' daily lives. Advanced technologies such as smart products, artificial intelligence (AI), and ubiquitous computing are increasingly influencing contemporary life. Their complex nature has brought new challenges and opportunities for users, especially the older generations, since the capabilities to adapt to new complex technologies can be perceived as more challenging by ageing users accustomed to earlier systems. This research aimed to develop insights and reflections on active ageing users' lived experiences and interactions with technology to inform future design and research practices in this area.

Influenced by ontological realism and social constructionism, this research applied an extended user study to interpret the lived experience of active ageing users with technology in natural settings. The study gathered evidence on the affective dimensions of the user experience of interacting with advanced technologies beyond controlled lab environments that capture only snapshots of the overall experience. I used three data collection stages, consisting of two rounds of interviews, two familiarising and demonstration sessions, and an extended user experience of 15 participants interacting with a social robot in their home environments. The result was a robust data collection system, starting with understanding users' lived experiences with smart products and including users' extended interactions. I used reflexive thematic analysis to analyse and interpret users' social-physical experiences.

The findings from this research identified mixed emotional experiences from fascination to wariness about advanced technology and its influence on participants' lives. My research recognised active ageing users' interaction with technology as a coevolutionary process in which both parties influence each other. The study observed six areas that contributed to how participants perceived interactivity of human-technology experiences – learnability, familiarity, responsivity, tangibility, playfulness, and novelty. Furthermore, my findings indicated that data privacy and security were not perceived as significant issues for most participants. However, the analysis revealed strong views on companionship in the current digital era, including a desire to differentiate between organic and non-organic interactions. Participants considered companionship a fundamental human quality and were concerned with technology replacing human relationships.

This research concludes that designers need to step away from the stereotypical views on active ageing users' interaction with technology that are only limited to design for accessibility and usability. My analysis recognises active ageing users as a diverse, knowledgeable and reflective demographic who have experienced some of the most disruptive technological changes in recent history. The results suggest that design practices need to account for social and subjective experiences rather than focusing only on users' emotional ratings of the experience. Similarly, my research presents a critical analysis of companion technologies. It recommends design practices to avoid generalising what 'companionship' means to all users. The study urges designers to spend time and effort understanding and unpacking what companionship means to users of technologies. My research proposes design practices to move beyond human-centred approaches and see the interaction as a coevolutionary process between the users, their environment and the technology.

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ATTESTATION OF AUTHORSHIP

I declare this thesis submission is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in the candidature of any other degree.

Parisa Moradi

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CO-AUTHORED PUBLICATIONS

Moradi, P., Sosa, R., and Hunting, A. (2019) A UX Pedagogy on Multimodal Aspects of Emotions, in Börekçi, N., Koçyıldırım, D., Korkut, F. and Jones, D. (eds.), *Insider Knowledge, DRS Learn X Design Conference 2019*, 9-12 July, Ankara, Turkey. https://doi.org/10.21606/learnxdesign.2019.15013

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CHAPTER 1. INTRODUCTION

"It's not rocket science. It's social science – the science of understanding people's needs and their unique relationship with art, literature, history, music, work, philosophy, community, technology, and psychology. The act of design is structuring and creating that balance."

- Clement Mok *(Everything Reverberates: Thoughts on Design,* 1998*)*

This research explores the experience of an under-researched group, active ageing users, interacting with smart products. It utilised an ontological realism and social constructionism perspective to study how active ageing users experience smart products. Through this exploration, I present my understanding of the future design research of smart products, which could be inclusive and meaningful based on participants' reflections on their lived experiences.

This chapter introduces the scope of my inquiry and the research problem I addressed. I discuss the background and justifications for the research, its aim, objectives, and an outline of the thesis structure divided into six chapters.

Throughout this research, I used the first-person writing style to keep with my research paradigm and epistemology and to account for my reflexivity, subjective experiences, and influence as a researcher in the field (Webb, 1992). First-person or active voice has been an integral part of qualitative research practices to express participants' perspectives and highlight researchers' responsibility for what they write (Given, 2008). The first-person writing style is a driving force for critical reflection and gives voice to personal narratives. The first-person voice is a tool of reflection and self-examination throughout research, and it is important not to be avoided or hidden away (Le Guin, 1998). Therefore, I have intentionally used it throughout this thesis to take responsibility for my interpretations and analysis.

1.1. Research background

Our fascination with creating intelligent machines dates back to ancient civilisations (Oh & Park, 2014), with particular attention to robotics and smart products over the last two decades. Lyardet and Aitenbichler (2007) define smart products as everyday products embedded with computational power, information, and sensing capabilities with three levels of knowledge: knowledge about themselves, their environment, and users. The ability to interpret their functions and features, environment, and users can enable these objects to interact, cooperate, and adapt autonomously. In this research, everyday products with such capabilities and embedded technologies are referred to as "smart products".

I conducted various investigations and interviews with expert designers, the supervision team, and other experienced product designers to explore different smart products appropriate for the study. I have done so by analysing different products and services domains and categorising suitable smart products into several groups, many of which are digital versions of previous technologies that were more manual and analogue (Appendix A). The main criteria for selecting the smart product included communication and social capabilities, assistance, IoT (Internet of things), AI (Artificial Intelligence), entertainment, tactile and kinaesthetic, and e-services. When analysing different products, only smart homes and social robots fit all the criteria of this research.

Setting up a smart home environment was beyond the scope of my study, given the costs involved and the limitations of setting up a smart home. Creating a lab environment would not have addressed the requirements for conducting exploratory research about a more natural user experience. Conducting field research on smart homes of users would have included issues such as variability of different setups at participants' homes and challenges with participants' recruitment. The final decision led to a study that mapped ageing users' behaviours interacting with social robots that fit better with the scope and aim of this study.

Social robots are autonomous robotic technologies that work collaboratively with people in human environments and open contexts. Ayanoğlu and Duarte (2019) suggest that the ultimate goal of social robots is communication and interaction with humans to perform tasks within the human environment. Social robots have been available technologies for years, but they have still not found their way into many people's daily lives. It is imperative for design practices to consider the complexity of the context and the emotions involved in the interaction.

Significant societal challenges such as the ageing population and healthcare have led to recent rapid growth in social robotics and human-robot interaction (HRI) studies. This research addresses aspects of HRI by exploring the experience of ageing users engaging with social robots over an extended time and what it means for them to live with such emerging technologies. However, since social robots are still very much a technology yet to come, I took a wider view of researching smart products and, more generally, technology in daily life to understand the issues that will be relevant for designers of future social robots.

While my research explores the interaction of active ageing users with social robots, it primarily investigates the questions around the lived or emotional experiences, relations, and perceptions of the ageing users with emerging technologies. Lived or emotional experience can be identified as subjective knowledge and sense-making process about the world and reality gained through engaging in everyday social and physical context and events (Nogueira, 2014; Blunden, 2016).

Ostrowski et al. (2021) suggest that older adults' values and their "told stories" about emerging technologies, prior to the interaction with social robots, offer significant sources for design knowledge. In the present research, I argue that understanding and empathising with ageing users' lived experiences can bring forward equitable and inclusive approaches to the design of future technologies, such as social robots.

Although research on users' personal narratives and participatory research is not a new approach (Šabanović et al., 2015; Lee et al., 2017), often, such studies do not analyse and include users' perspectives in the research. Instead, most of these investigations use this data to generate researcher-focused design scenarios and proposed use cases (Caleb-Solly et al., 2014). By analysing users' lived experiences and perspectives, my study aimed to explore the social context and nuances that users experience when interacting with technologies that could otherwise be missed in controlled and experimental studies (Loveys et al., 2020).

Howe and Strauss (1991) argue that generational categorisation offers a more comprehensive personality generalisation than any other social category such as race, religion, or gender. A generation's peer personality can represent the collective stances of lifestyle, politics, gender roles, and social attitudes (Sandeen, 2008). I chose to investigate the lived experience of an older generation of users who are still active, living independently, and invested in interacting with emerging technologies.

Initially, I had planned to target participants in the prior and post-retirement age group (60+ years old). During the early stages of the recruitment, participants in this age category were reluctant to participate. Still, I had slightly younger people interested in participating in the research. I decided to expand the age group to 50+ years old since participants in the middle-aged group will soon be in the category of older demographics. It allowed me to study their experiences as a way for designers to anticipate how older adults will be in the next 20 years. However, I was mindful of capturing any noticeable differences between the results collected from the selected age groups. Throughout this thesis, the term "ageing users" represents the active older generation of users aged 50+ as my research's targeted demographics.

1.2. Research problem

Despite the rising number of research and projects in the field of human-computer interaction (HCI) and user studies, the emotional and social context of ageing users interacting with emerging technologies has received little attention in the design literature (Lee & Coughlin, 2015; Cortellessa et al., 2018; Wilson, 2018; Barbosa Neves et al., 2019). Most research on older users' interaction with technology, while significant, focuses on senior users who are mostly part of bigger social groups, such as retirement homes. Little research and attention have been paid to the lived experience of the ageing generation outside of this context (LeRouge et al., 2014; Lu, 2017; Ratzenböck, 2017).

Given that most research on Ageing with Technology has focused on designing for accessibility and usability, there is a clear gap in the current understanding of active ageing users' experience regarding emerging technologies, such as smart products. An explanation for this absence in the literature is that most user studies have used lab-based usability tests, which only capture snapshots of users' interactions (Loveys et al., 2020; Noguchi et al., 2020). There is little consideration of the holistic and extended research on the user-technology relationship that considers the emotional and social aspects of the experience.

My research aims to explore and analyse the emotional and social aspects of the relationship between the users and technology beyond lab-based studies and conduct holistic research in the home or more natural environments. Labs-based methods cannot capture the entirety of the relationship between users and the technology (Rogers & Marshall, 2017). My study seeks to extend the research on ageing users by capturing and analysing a more naturalistic experience. A naturalistic experience in the thesis refers to when users can interact and experience a particular product at different points in time and over an extended period without researchers monitoring them or suggesting what form of interaction to have with a product (Sung, 2011).

The present research investigates the emotional experiences of ageing users and smart products. It presents an experimental framework I developed to support exploring such experiences. Exploratory research aims to generate understanding and insights instead of developing a theory. The intention is that my research findings contribute to future technologies' research and design practices.

1.3. Aim and objectives

This research aims to report on the emotional experience of active ageing users interacting with smart products, particularly social robots. The approach illustrates active ageing users' views on the notion of meaningful and emotional experiences in detail and what such experiences represent. The objectives are:

- Study active ageing users' interaction with social robots.
- Investigate the emotional transitioning process that active ageing users are going through to adapt to new smart products.
- Demonstrate how to study smart products from an emotional experience viewpoint.
- Analyse the results of the study in view of current related literature and design practices.
- Discuss the insights from the study to explore ways of creating more pleasurable and inclusive experiences for active ageing users while benefiting from the advantages and strengths of smart products such as social robots.

1.4. Thesis structure

This thesis is structured into six chapters. Chapter 1, the current introductory chapter, illustrates the essential information on the research context, including the research problem concerning User Experience studies. I present my aim and objectives for the research and provide an overview of this thesis report's structure.

Building on the ideas introduced in the current introduction, Chapter 2 reviews the literature and research on technology, emotion, and user studies. First, I present research on the complexity of human-technology relations. I then explore the literature on the importance of inclusive design practices on active ageing users' interaction with technology. I investigate and compare different theoretical frameworks in user studies to inform the context of this research. Lastly, I identify the gaps in the literature.

In Chapter 3, I present my research question. To analyse the human-technology relationship, I explain my philosophical positioning of ontological realism and social constructionism epistemology. I introduce my conceptual framework and the rationale for the methodological approach, data collection, and analysis. I then discuss the importance of the extended multimodal user research approach for understanding the complex nature of human-robot interaction. Lastly, I outline my ethical consideration for conducting this research, in which I also present my personal background and the foundation for this PhD research.

In Chapter 4, I address the findings of this research. I organised the chapter into five sections addressing the key identified themes. In Theme 1, I illustrate participants' perceptions of advancements in technology. I explore the dichotomy of what technology offers as useful in Theme 2. In Theme 3, I present participants' outlook on interactive technologies and affective interactions. I share participants' reflections on privacy and information sharing in Theme 4, and lastly, I introduce participants' worldviews and beliefs concerning companion technologies in Theme 5.

In Chapter 5, I discuss the results and analyse the insights that advanced the understanding of the "Ageing with Technology" concept. I argue there are boundaries between human and technology coevolution, which design practices need to consider. I discuss the social and emotional trajectory of ageing with technology. I elaborate on participants' desire for a different type of companionship and how they do not want smart products such as social robots to replicate existing organic companionships that humans and pets offer. I propose that participants' views on privacy from a negotiating position are not the stereotypical view of research on older users' literacy on data privacy matters (Volkmann et al., 2020). Lastly, I present the regulatory approach to design intentions, a theoretical process for creating inclusive and meaningful technologies that give agency and power to ageing users at different phases of interactions.

Chapter 6 concludes my research approach to studying active ageing users' emotional experiences with smart products. I summarise how the findings answered the research questions and conclude with a summary of the research contribution, limitations, and the identification of future research opportunities.

Lastly, I provide the essential supporting documents in the appendices.

1.5. Summary

The needs of an ageing population regarding their relationship with technology are rarely given the necessary focus in design research. This chapter discussed what constitutes smart products and social robots and why it is important to research an active ageing generation of users. I presented the research problem and reasoning for conducting holistic research in HRI, HCI, and user studies. I outlined the aims and objectives of my research and the importance of investigating ageing users' perspectives on what represents meaningful and emotional experiences when they interact with smart products.

CHAPTER 2. LITERATURE REVIEW

"When you feel connected to everything, you also feel responsible for everything. And you cannot turn away. Your destiny is bound with the destinies of others. You must either learn to carry the Universe or be crushed by it. You must grow strong enough to love the world, yet empty enough to sit down at the same table with its worst horrors."

- Andrew Boyd *(Daily Afflictions: The Agony of Being Connected to Everything in the Universe,* 2002*)*

2.1. The relationship between humans and technology

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2.7. Research gap

2.8. Summary

To better comprehend the experience of active ageing users interacting with smart products, I start Chapter 2 by presenting the literature on the human and technology relationship. I then explore the studies on active ageing users' interaction with technology. I evaluate different research approaches to understanding the human-technology relationship. I then assess prominent design theories on the human-technology relationship. I explore studies on the influence of users' emotional experiences and the context of their interaction with technology. Lastly, I highlight the key influential factors of user experience identified in the literature to be considered in designing the proposed research. I then outline the gap in the literature that the present research aimed to address. Figure 2.1 visualises the literature review process covered in this chapter.

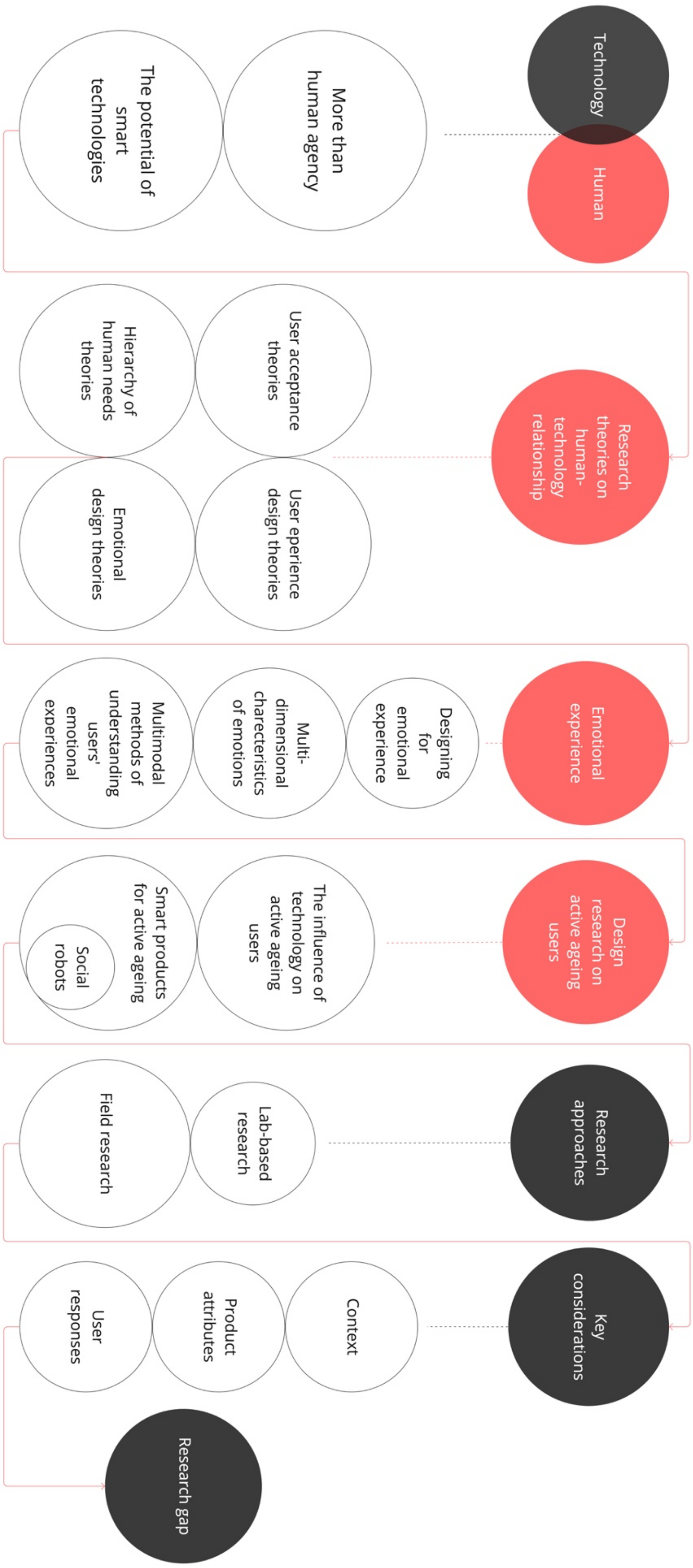

Figure 2.1. A visual summary of the literature review process

2.1. The relationship between humans and technology

The field of design has shifted its focus from designing artefacts or objects for humans to designing the interaction between the two or their "fluid assemblages" (Redström & Wiltse, 2018). However, interaction design studies often draw lines between the human as subject and technology as object and present the interaction as a specific activity in between. From the post-phenomenological approach to human-technology relations (Ihde, 2021), humans and technology are not seen as separate entities with activities in between. Instead, humans and technology shape and define each other and their relationship, as well as the larger relationship between humans and the world (Verbeek, 2021). From this view, design is not simply creating a functional, usable, engaging, and efficient product but rather designing a relationship in which experiences, worldviews, knowledge, morals, decisions, and ways of living form and take shape (Miller, 2021).

One of the leading researchers in the area of digital technology and user experience is Sherry Turkle. Two of her main books I investigate here are *Alone Together* (Turkle, 2017) and *Reclaiming Conversations* (Turkle, 2016). Turkle argues that technology has become a 'phantom limb' of humans. She provides examples that people perceive their smartphones as part of their bodies, and not having them at hand would feel like a missing limb. She suggests that the constant and mobile connectivity of the world of smart products means humans can leave their physical reality at any time to go anywhere virtually. Turkle (2016) further notes that people refer to their smartphones as a positive place in their lives, a place that has vanquished loneliness. She believes people are, however, vulnerable to the constant feelings of connection technology offers. Such vulnerabilities and feelings in the interaction emphasise the importance of considering and addressing people's emotional experiences in the design of future products and moving beyond only focusing on the usability and performance examination of interaction.

The main topic Turkle discusses in her research is the empathy gap in the current digital era. She suggests an anthropological approach is needed to listen to and observe how the interaction between technology and users is shaped. Turkle's examples of smartphones demonstrate that people are shaped by their tools. We are still very early on in the development of smart products, AI, and IoT systems. How we investigate the emotional and social influence of such technologies will have an effect on future designs. Turkle's critical view on popular uses of technology emphasises that further assessment is needed to investigate the impact of human-technology interaction on social and emotional lives.

Cohen (1972) argues that all new technological advancements raise concerns about their use and values in human lives and often create a 'moral panic' before they gradually become accepted. The gap between the time society or culture tries to catch up with a new technology or innovation can cause social problems referred to as 'cultural lag', a concept first introduced by Ogburn (1922). The idea of the cultural gap presupposes that technology has independent effects on society at large and does not consider the causality of technology. Such a technologically deterministic view misses the opportunity to account for the role of human agency in shaping the technology.

In contrast, social deterministic views, such as the work of Green (2002), argue that every technological advancement throughout history was born out of a human need, such as social, economic, political or military needs. They perceive that advancement in technology is determined and shaped by society and the power structures that exist in it.

All views about the influence of technology on social lives and society's influence on technological development bring important conversations for designers to consider. Instead of considering technology as overpowering and harmful forces or purely functional objects to address human needs, the combinations of such views create the opportunity for exploring the relationship between humans, technology, and the influence they have on each other and the world. Human perception of the world is, therefore, intertwined with technology. For example, Ihde (2009) suggests that how humans currently perceive a star or the brain would be impossible without taking into account the mediating role of telescopes or MRI scanners. Technology and human perception are innately interlinked.

2.1.1. More than human agency

User studies in the HCI and HRI have been gaining more attention and are rapidly growing (Kuniavsky, 2007; Hornbæk & Hertzum, 2017; Schott & Marshall, 2021). Most research in this area has focused on usability and functionality rather than exploring what it means to design a meaningful experience. Vermeeren et al. (2016) argue that as the field of

HCI is shifting toward user research, more effort is needed to move beyond utilitarian investigation and unpack the emotional aspects and contexts of the experience.

Coulton and Lindley (2019) reason that the emotional experience of a user interacting with an artefact in the digital era is not just a simple experience between the two. They argue that with the growth of IoT, AI, and smart products, the interdependency of the actants involved in the human-technology interaction does not simply end with the artefact in use and the human. Smartphones are not just phones. They are computers that do much more than just making calls. Smart TVs are not just a device for airing TV programmes. They are connected to networks and cloud systems, collect users' data, and sell or use those data to provide feedback to television networks or other companies.

It is essential to consider many other aspects influencing users' experience, such as technical, political, and social constraints involved in an interaction. In the example of a Smart TV, the process of watching a TV program can also mean data collection. The device must be connected to cloud systems, which in return requires higher security of devices to protect them from viruses and cyberattacks. It also means the product is reliant on the cloud system. A fault in cloud servers could hinder the interaction. For example, when the company that created the robot, Jibo[1], ran out of business, it stopped the cloud services, and as a result, the robots would not function, and users could not use them anymore. Therefore, interactions do not happen in isolation from their social and technological environments.

Likewise, McCardle (2017) advocates that the human factors in designing autonomous and smart products need to be carefully studied and analysed. More research is required to design suitable, fitting, flexible, and effective technologies.

According to Latour (1999), technical mediations translate into a course of action. His famous analysis of a speed bump illustrates what he means. Latour describes a speed bump as

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[1] More information about Jibo: https://www.theverge.com/2020/7/23/21325644/jibo-social-robot-ntt-disruptionfunding

a force to slow down a driver. As a result of the speed bump, the driver's goal is converted from slowing down for the safety of pedestrians into deceleration to protect the car's suspension. As opposed to road signs, warnings posts, and delineators, engineers have used concrete mediators. The driver's course of action and responsibility to slow down have been inscribed into concrete. Latour uses 'inscribed' instead of other words such as 'engraved' to avoid implying that a human agent is imposing human determination on an object. He stresses that objects can also act, influence goals, or redefine them. For Latour (1999, p. 189), the speed bump is a unique kind of a 'technical delegate' that influences the absence and presence of various other agents. Moreover, it directly impacts the daily urban life of cars and humans. He suggests that such delegations are impossible to be separated as individual actions, and such separations are not even appropriate.

Latour's concept focuses as much on the intentions of human beings as on the functions of technology. It does not invoke a distinction between humans and non-humans in the extent to which the terms are applied. Therefore, technology and humans mutually influence each other. That is, there are mutual mediations between humans and technology. In this view, there is more than human agency playing a role in the interaction. Hence, in my research, I refrain from using terms such as 'user-centred design', as their scope emphasises and limits their exploration to only humans.

Gertz (2018) argues that while technologies are advancing faster than ever, they are also becoming more competent at carrying out tasks that humans previously performed. Yet, humans are not necessarily advancing as a result. Instead, they are becoming more dependent on technologies. With technologies emerging to become more capable of carrying out complex tasks, they also expand and embed further into human lives. Gertz asserts that it might be a mistake to suggest that technologies could advance in parallel and independently of humans. Similarly, it could be a mistake to assume that humans can become reliant on technologies. Instead, he argues that the division between humans and technology is a remnant of the traditional dualistic practices of reasoning and thinking.

Gertz presents an example of fluorescent lighting being replaced with daylight-replicating, natural-seeming lighting, which can even be synchronised to adapt to the circadian cycles. These productivity-enhancing lighting systems are intended to increase employees' happiness and performance. Consequently, not feeling good at work, not being more productive, and being unhappy is no longer workplace issue. Rather, there is an implication that something is not right with an employee who feels unhappy in an environment intended to boost happiness and well-being. Instead of questioning the world around them and its structure that produces negative emotions, technological interventions similar to these lighting solutions may make humans doubt themselves.

Thus, if research mainly evaluates technological innovations through metrics such as efficiency and happiness defined by their designs, it will likely disregard the impact of such technological innovations on users' identities and emotions, humanity, and the trustworthiness of the research evaluations. Research and design practices need to carefully examine and ensure design solutions are aimed at understanding and constructing values, goals, and views based on the coevolution of humans and technology. According to Ostrowski et al. (2021), one way to understand the coevolution of humans and technology is to engage users in long-term research and design practices and analyse their lived experiences with previous technologies within their context.

It is critical to investigate the social and emotional impact of new technological interventions and move beyond designs focused only on the usability of the invention and the productivity of users.

2.1.2. The potential of smart technologies

New digital technologies bring both challenges and opportunities to the fields of design. Smart technologies are changing society in the ways people interact, communicate, talk, live, and even define interactions (Consortium, 2007; Kim & Mauborgne, 2014; Greengard, 2015). According to Gartner (2018), by 2028, the digital transformation of the economy will demand the digital dexterity of people as the new workforce will be a symbiosis of humans, AI, and robots. However, the effects that these technologies might have on our future are still a serious social and ethical concern (Greenfield, 2017).

Smart technologies are often created without considering people's emotional and lived experiences and social expectations beyond usage and aesthetic elements (Schifferstein & Desmet, 2010; Lee et al., 2011). Technologies designed with a lack of empathy for their users can fail to deliver pleasurable experiences, creating a sense of isolation for the users (Standage, 2005; Rama Murthy & Mani, 2013; Shin et al., 2017). Such technologies mostly aim to remove the human touch from the product and service offerings for the purpose of delivering precision and efficiency (Vermesan et al., 2017). While new technologies such as AI and IoT can bring advantages to the field of design by making products “smart”, they could be limiting if applied blindly and without consideration of the users’ needs for emotional attachment and bonding. The advantage of design practices embracing empathy is in how the use of products could deliver a meaningful and pleasurable experience for the user (Kolko, 2014; Hanington, 2017).

According to Rose (2014), the fragmented multifunctional nature of new, highly technologically advanced products can confuse people and prevent them from having deep, meaningful experiences. A high-tech device can provide multiple experiences, such as a smartphone that allows users to email, play games, do mobile banking, connect to search engines, take photographs, and set the alarm. Therefore, such smart devices can elicit many different emotions and experiences. Smart devices are becoming more complex, and there is a need to improve how these products socialise and communicate with their users. This complexity urges design practices and processes for careful consideration and empathy to better understand users’ emotional experiences confronted by all new technologies.

People want to experience the joy and pleasure of using products, minimising any confusion and enabling them to learn how to use products without difficulty (Lee et al., 2011). Delightful and simple products could intensify people’s desire to bond with them (Norman, 2013). At the same time, people can experience positive emotions in facing and overcoming challenges in learning new skills, feeling ambiguity and fear through using a new product and rethinking and interpreting its role in their lives (Gaver et al., 2003; Sengers & Gaver, 2006; Sanches et al., 2019; Ryding et al., 2021).

As products become more technologically advanced, intelligent, and sophisticated, designers could further explore and investigate how users interact with them at an emotional level. Therefore, designers need to investigate how these technologies will influence users in transitioning from conventional products to smart devices. Russo and Ferrara (2017) suggest that the notion of smart objects or spaces requires changes in design practices with regard to sensible aesthetics and interaction design. They argue that designers need to implement smart solutions and “smart aesthetics” that can respond to the smart technologies reshaping human lives and behaviours.

A design succeeds by stimulating suitable affects in users that convey a positive experience for them (Reydet & Carsana, 2017). Delivering suitable affects can create a harmonious relationship between users and technology that can result in a cooperative and beneficial natural form of interaction (Gill, 2012). If the technology is designed well, these subconscious interactions occur without any struggles and enhance people’s lives. Research and design for interactions that stimulate meaningful and positive affects require understanding users’ emotional and lived experiences (Ciolfi, 2007). Understanding users’ lived experiences could define how to implement technology that could positively benefit users and not add any confusion and frustration for them.

2.2. Research on the human-technology relationship

Over the last few decades, there have been many different approaches to describe the fundamental mechanism of the human relationship with technology (Davis, 1989; Forlizzi & Ford, 2000; McCarthy & Wright, 2004; Kaptelinin & Nardi, 2006; Bargas-Avila & Hornbæk, 2011; Doherty & Doherty, 2018). The growing number of studies on the topic demonstrates considerable interest in developing approaches to understanding and designing the human-technology relationship instead of simply designing artefacts for use.

This section reviews several theories relevant to the present research, as summarised in Table 2.1. These studies have considered various factors of the human-technology relationship, such as human needs, product characteristics, different levels of interaction, properties of user engagement, and external and internal attributes influencing the human-technology interaction.

Table 2.1. Influential theories and frameworks on the human-technology relationship

Researcher (Year)	Characteristics	Significance
Maslow (1954)	Hierarchy of human needs: 1. Physiological needs 2. Safety 3. Belongingness & love 4. Esteem 5. Self-actualisation	Insight into different levels of human needs that can be addressed through the design process. It provides a primary platform for designers to target varying human needs.
Terninko (1997)	Product features: 1. Basic features 2. Performance features 3. Excitement features	A helpful categorisation of design elements from the essential functions to surprising factors. It helps in targeting users' emotional experiences.
Jordan (1998)	Three types of product benefits: 1. Practical 2. Hedonic 3. Emotional	A better understanding of different benefits and results of the product interaction process from aesthetics to functionality.
Jordan (2002)	Hierarchy of user needs: 1. Safety & well-being 2. Productivity 3. Usability 4. Pleasure	Understanding the importance and benefits of positive psychology in users' behaviours.
Norman (2004)	Three user responses: 1. Visceral 2. Behavioural 3. Reflective	Different users' responsive behaviour toward products that are based on their level of engagement.
Desmet and Hekkert (2007)	Different types of interaction: 1. Aesthetics of the products 2. Meanings of the product 3. Emotions of the products	Understanding different aspects of products that can engage users emotionally while excluding other surrounding stimulus.
Brakus et al. (2009)	Four dimensions of user experience: 1. Sensory dimension 2. Affective dimension 3. Behavioural dimension 4. Intellectual dimension	Understanding different elements that influence users' experiences; from aesthetics to symbolic and semantic values.
Pucillo and Cascini (2014)	Four different levels of affordance: 1. Experience affordance 2. Use affordance 3. Effect affordance 4. Manipulation affordance	Proposes a framework of user experience based on affordances allowing the designers to involve users' interpretations of objects in their design.
Chandler and Lusch (2015)	Five properties of users' engagement: 1. Temporal connections 2. Relational connections 3. Future disposition 4. Past disposition 5. Present disposition	The study proposes five properties of user engagement based on a psychological state which occurs through interactive user experience.
Wright et al. (2018)	Different characteristics of an experience: 1. Compositional 2. Sensual 3. Emotional 4. Spatiotemporal	Identifying different aspects of the user experience with technology
Hassenzahl (2018)	Different consequences of products: 1. Satisfaction 2. Pleasure 3. Appeal	Different levels of emotional involvement in the user-product interaction
Blut et al. (2022)	Unified theory of acceptance and use of technology (UTAUT): 1. Performance expectancy 2. Effort Expectancy 3. Social Influence 4. Facilitating conditions 5. Demographic differences 6. Hedonic motivations 7. Technology use and behaviour	The theory was developed through reviewing and integrating eight dominant methods and models. It has been widely employed in technology adoption and diffusion research as a theoretical lens by researchers conducting empirical studies of user intention and behaviour.

2.2.1. User acceptance theories

Research on the acceptance, adaptation and use of information technology (IT) is one of the most developed and well-established streams of research aiming to examine the adoption and use of new technologies (Sia et al., 2001; Venkatesh et al., 2003; Sin Tan et al., 2009; Sarker & Valacich, 2010).

One of the most researched theories on user acceptance and adaptation is the unified theory of acceptance and use of technology (UTAUT) framework (Blut et al., 2022). The theory was first designed by reviewing and integrating eight major frameworks, namely: the theory of reasoned action (TRA), social cognitive theory (SCT), the technology acceptance model (TAM), the theory of planned behaviour (TPB), the motivational model, a combined TBP and TAM, the model of PC utilisation, and innovation diffusion theory (IDT).

The original UTAUT framework (Venkatesh et al., 2003) explored the influence of a technological system's usefulness, ease of use, social influences such as the users' social norms and people's opinions on technology, technical and infrastructure support as direct determinants of user acceptance and use of technology. The theory considered factors such as users' characteristics and experiences with technology and voluntariness of use as key moderators of the experience. The framework further extended to include the influence of factors such as hedonic motivations like the pleasurable aspects of technology, price value, and users' habits (Venkatesh et al., 2012). The latest extension of the theory proposes adding technology compatibility, user education, personal innovativeness and costs of technology as direct determinants of user acceptance of a technology (Blut et al., 2022). The model also includes moderator factors such as national culture, perceived control, and type of technology (see Figure 2.2).

The UTAUT model highlights the complex nature of user experience that goes beyond simple usability testing. It considers various factors which directly and indirectly influence the experience. The model's strength lies in its consideration of contextual, behavioural, and environmental conditions that contribute to the users' experience of interacting with technology. While the theory presents a detailed and well-planned model to consider, some critiques suggest that the complexity of the model, with many variables for predicting intention and behaviour, could add to the complexity of studies in this domain (Bagozzi, 2007; Li, 2020).

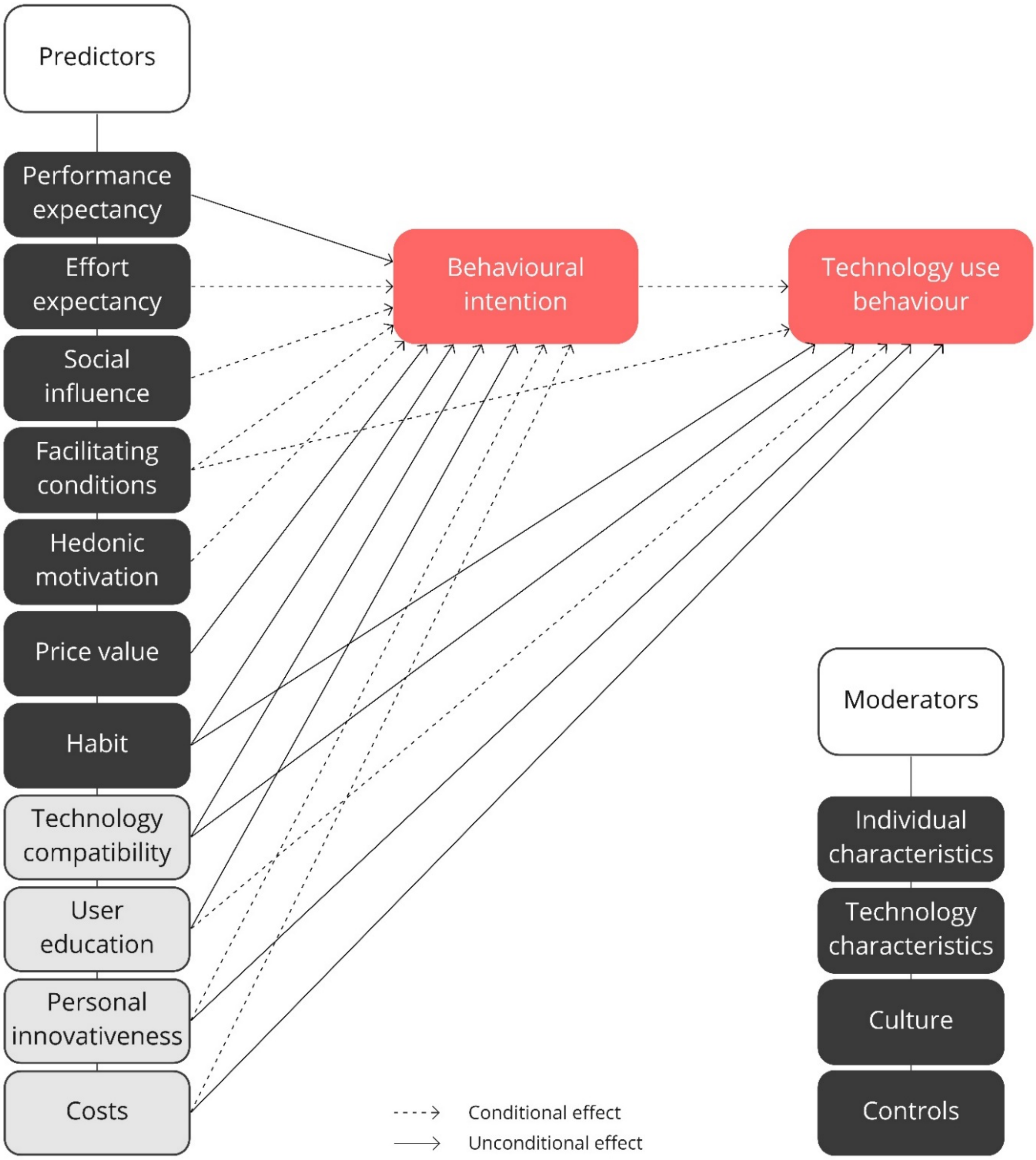

Figure 2.2. UTAUT framework (Blut et al., 2022)

Whilst UTAUT is highly influenced by other fields such as human behaviour and cognitive studies, from a design perspective, users' emotional influences, such as past experiences, memories, and personalities, have not been explored much in research that uses the UTAUT framework. The framework seems to generalise cultural and individual categories to gender, age, masculine versus feminine, and individualistic versus collectivistic cultures. Further research is needed to explore the influence of factors such as the diversity of user preferences and personalities, multicultural environments with mixed cultures, races, ethnicities, and languages, such as Auckland city in New Zealand (Gooder, 2017), on user acceptance and use of technology.

2.2.2. Hierarchy of human needs theories

Studies suggest that during a thriving economic time, when people have secure incomes and jobs, their needs tend to move up Maslow's hierarchy, from more basic needs for food and shelter to the self-actualisation level (Datta, 2014; Lee & Hanna, 2015). Having accomplished their more basic needs, people want to "make every moment count" and thus want satisfying pleasurable experiences. Moving down from self-actualisation to the esteem needs level is the stage where people desire accomplishment, respect, social acceptance, and self-belief. At this level, people want not only stable incomes but also seek fulfilling jobs and recognition. Esteem level is deeply rooted in how people seek internal acceptance and validation from others in society. The other lower levels of the chart are considered people's basic needs. If users are grouped into these stages, they are dealing with their basic social and everyday needs.

Maslow's categorisation of human needs (Maslow, 1954) has been used and researched across many disciplines to explore and explain human motivation's correlation with the context of behaviour. The theory is widely popular due to its simplicity and ease of use. In health care and psychology, the model is commonly used and taught as a framework for understanding and identifying patients' needs (Rogers, 2022). In the field of design and HCI, the categorisation of users' needs can help to explain the differences in individuals' purchasing decisions and why a growing number of users are prioritising the emotional experiences and conspicuous consumption of products (Tully et al., 2015; Siepmann et al., 2022).

There have been significant criticisms of Maslow's model for not accounting for cultural and locational differences and influences on people's needs and priorities (Gambrel & Cianci, 2003; Fallatah & Syed, 2018). For example, different cultures and contexts might influence people to prioritise safety over esteem or esteem over belonging. Furthermore, Maslow illustrated the higher levels of his model based on exceptional and creative figures such as Einstein, Eleanor Roosevelt, Spinoza, and Abraham Lincoln. Thus, there are concerns about the model being biased and predetermined and failing to expand on social and intellectual differences (Mittelman, 1991). Lastly, research also suggests that the different levels of the hierarchy overlap each other continuously (Deckers, 2018).

Jordan's hierarchy of needs (Jordan, 2002) is a more recent model focusing on users' needs. The model has four levels of user needs, with safety and well-being secured as the foundation. Following productivity and usability, pleasure is placed on the highest level of the chart. Similar to Maslow's hierarchy, Jordan's model indicates that once users' functionality and usability needs are satisfied, they will seek added value and emotional benefits (Ozcelik et al., 2011). Referring to the statement of Bonapace (2002), in today's world, products are assumed to do what they are supposed to do. They are expected to be easy to use and user-centred. Users will not consider a product if it fails to meet these basic requirements. Hence, for products to be noticed, they need to move beyond functionality and usability to meet the pleasurable stage of Jordan's hierarchy of user needs.

One of the limitations of Jordan's model is the fixed hierarchal order of users' needs. It suggests that a product needs to meet functionality and usability before the pleasurable stage of users' needs. However, research suggests that the prioritisation of these needs can vary based on different contexts (Karapanos et al., 2008). Individual differences such as people's values can influence their preferences in pleasurable products; some users might seek playfulness over simple and minimal products, while others might prefer the opposite. Similarly, different products or use cases of the same product require addressing different levels of user needs (Hassenzahl & Ullrich, 2007). For example, a user's needs may vary when using a computer for gaming versus using it for an emergency job-related task.

2.2.3. User experience design theories

According to Hassenzahl (2018), products have specific features for delivering assigned tasks. Based on a designer's intention on how to design these features, the product will end up with characteristics that will have three levels of user experience consequences. The first level of consequences is when the result of using a product matches the user's expectation. In other words, when a product delivers what it was supposed to do, the user experiences a sense of satisfaction. In contrast to satisfaction, the pleasurable consequence of using a product is unexpected, and the surprise element brings a sense of pleasure and joy to the user. Finally, the appeal consequences refer to the integrated experiences and desirable feelings towards a product in specific situations that causes emotional reactions in users.

Wright et al. (2018) propose that user experience results from an engagement with or through technology. They have identified the user experience into four interrelated characteristics and levels that make up the ultimate experience. The first level of user experience is the compositional structure – the process of making sense of what the product is and how it works. The second characteristic of the user experience is the sensual experience – the feeling and sensory elements of engagement. The sensory aspects of user experience result in the third level of user experience – emotional characteristics such as joy, anger, frustration, and compassion. The final level of user experience is spatiotemporal – the experience of actions and events felt in a particular time and space, which occurs in every encounter. Both space and time can construct the result of the experience.

Although Wright et al. (2018) categorisation of user experience helps to understand the process of a user engaging with a product, it can be, to some degree, general as it lacks focus on other influential factors and the different levels and stages of user experience and interaction over time (Kujala et al., 2011). Users may describe an experience as pleasurable and engaging based on social factors, the status of the product, and being part of an existing trend, even though the construction or sensory elements of the design might not be of interest. Moreover, the users' emotional experiences are shaped and influenced by their individual lived experiences and prior interactions (Barrett et al., 2019). Different contextual factors need to be considered to understand the meaning of a pleasurable experience.

In service design, Chandler and Lusch (2015) explored user experience through unpacking different properties of engagement, specifically temporal and relational connections, as well as future, past and present dispositions. Both temporal and relational connections are considered external factors that represent the influence of the passage of time and social roles on the experience. Dispositions relate to internal factors that influence user experience, including human goals, purposes, unique pasts, memories, and associating and making meanings to the present time and place.

2.2.4. Emotional design theories

A range of factors can brand a product as pleasant and pleasurable. According to Terninko (1997), three types of features bring differential advantages for products – basic, performance, and excitement. The expected product features that a user expects to receive are called basic features. Performance features are related to better functionality that can result in higher user satisfaction. Lastly, the excitement features are the surprise elements, which are not expected. These are the elements that enhance the whole user experience. As Mann (2002) suggests, one or more excitement features or 'wow' factors must be applied in product design to evoke pleasurable feelings. The whistling sound of an Alessi kettle[2] when the water boils can be a straightforward yet surprising design.

Humans are emotional beings, and the design field is strongly based on human behaviours and emotions. Jordan (1998) proposes that there are three main pleasurable benefits linked to products. Hedonic benefits and pleasures are related to sensory experiences and aesthetic elements linked to products (Zhang et al., 2017). Recognising a product as beautiful or enjoying the physical feeling of using or touching it are good examples of hedonic benefits. Emotional benefits refer to how a product affects the user's mood and emotions. The beneficial aftermaths of products' tasks and what they are designed to be used for are the practical benefits (Hanington, 2017). Design practices can consider all three pleasurable benefits and create practical and emotionally meaningful solutions.

Goode (2016) gives an example of a smart coffee machine that can connect to Alexa or other AI systems, which learns users' routines and saves their favourite coffee recipes as personalised experiences. While it might seem like a small task, it illustrates the way smart homes are evolving. Research and design practices need to investigate and identify such factors as they are important motivators for users' purchasing and decision-making. Creating

[2] More information about Alessi Kettle: https://alessi.com/collections/bollitori/products/9093-bollitore

emotional and personalised user experiences can differentiate a product from others (Desmet & Hekkert, 2007).

Nonetheless, it is not an easy task to understand the emotions that influence users' decisions. Emotions occur at every stage of a user's experience. They take place during the first impression of a product, product appraisal, purchasing decision, and first-time interaction (O'Shaughnessy & O'Shaughnessy, 2003). Secondly, emotions influence users' satisfaction evaluation after purchasing and during the user interaction (Csikszentmihalyi, 1997). Lastly, emotions can result in product longevity by establishing an emotional bond between a user and a product that can encourage long-term use (Norman, 2004). The study of user experience can tackle different problems from various perspectives due to its ability to handle users' emotional needs in using a product (Huang et al., 2014).

2.3. Emotional experience

Vygotsky's concept of *perezhivanie* (Vygotsky & Leontiev, 1974) is translated into English as "emotional experience" or "lived experience" (Blunden, 2016). An emotional experience is the result of any interaction between users and their world, with an emphasis on the importance of users' subjective understanding of a situation. Emotional experience, from this view, is a relationship between personality characteristics and environmental characteristics. Users' previous experiences determine what they bring to a situation and how they experience it. In other words, how a situation is refracted by the user is the emotional experience, a unit that integrates the user and the world. Therefore, an emotional experience is a process in which a user perceives and attributes value and meanings to a given situation (Nogueira, 2014).

Research has long established that products with the ability to stimulate positive emotions and pleasurable experiences for users increase the purchasing desire, possession, usage, and interaction (Holbrook, 1986; Wakefield & Baker, 1998; Lloveras et al., 2004; Desmet & Schifferstein, 2012; Norman, 2013; Thoring et al., 2016). Emotions, whether pleasant or unpleasant, can affect people's lives significantly and play a considerable role in triggering a sense of belonging and fondness. Gill (2012) states that a design that connects with people on a very emotional level results in better performance, a richness in the interactive experience, and a sense of enjoyment.

MacLean (1952) introduced the concept of emotions occurring through our interconnected brain structures. According to Catani et al. (2013), our limbic system is a complex arrangement that connects visceral states and emotions to our behaviours and reasoning. They cited works by scientists such as Papez (1937), Yakovlev (1948), and MacLean (1952), confirming that emotions occur either from rational and cognitive activities or from visceral, intuitive and somatic discernments. Other studies that follow the psychological constructionist approach, such as Lindquist et al. (2012), suggest that emotions are constructed of more general brain networks instead of a specific brain region like the limbic system. According to these studies, emotions are created by the human brain predicting and constructing the world in specific situations based on lived and past experiences (Barrett, 2017).

Inferring users' emotions from their facial expressions is commonly assumed to be a sufficient approach to identifying emotions. There are six popular categories of emotions frequently used in user research. These emotions consist of happiness, surprise, fear, anger, disgust, and sadness rooted in the work of Ekman (1999). However, Barrett et al. (2019) recommend that how people communicate these emotions varies in different contexts. Their study illustrates the complexity of emotional expressions and perception of emotions. While they agree that facial expressions are a significant source of information, they also urge researchers to discern emotions by examining people's expressions and perceptions across various situations and contexts that are different in their physical, psychological, and social features. Recent studies that have utilised more discovery-based research approaches reveal emotional multiplicity rather than homogeneity in how people make sense of facial expressions and emotions (Gendron et al., 2018). They support a user-constructed account for the perception of emotions.

Users' emotional responses can be triggered by implementing sensory-driven activities and stimulating their memories (Rolls, 2015; Satpute et al., 2015; Cardinali, 2018). Although human memory can be imprecise, it can find relationships and similarities among items that no computer or AI would likely identify as similar or connected. The limbic system plays an essential role in users' emotional responses to sensory stimuli. One of the critical functions of this system is to differentiate the positive and negative elements of our environment (Cardinali, 2018). It is also responsible for the natural reward circuit, where the sensory stimulation releases dopamine. It encourages positive experiences, such as the sudden desire for shopping as a reward (Catani et al., 2013).

Digital technologies are influencing the design of everyday products to be more complex and multifarious. The emotional attributes of smart products can stimulate various emotional experiences. Many concerns of users happen around emotions, such as their expectations of a product's performance, aesthetic preferences, and social norms, values and beliefs (Schifferstein & Desmet, 2010). Therefore, the excitement of possessing a product or the fun a person experiences by having or using a product are the results of wide-ranging emotional responses as well as rational decision-making (Menninghaus et al., 2017). For instance, the experience of watching television can be a combination of different emotions, such as happiness, joy, pain, rage, fear, and belief. Saraiva et al. (2019) comment that with smart products such as social robots that are intended to interact with people, emotions become an essential part of the interaction. Their research presents the idea of affective and emotional interactions constituting various factors, including the aesthetics of robots, their features, functions, communication, movements, and the environment. They argue that the link between emotions and HRI can facilitate and deliver affective user experiences.

2.3.1. Designing for emotional experience

Studies around emotional experience were first started by Nagamachi (1995), who proposed a method for measuring emotions called 'Kansei engineering', which soon became a popular approach among Japanese product industries. Kansei engineering is one of the most used and studied self-reporting assessments for measuring emotions because of the attractive benefits of the method's quantitative and analytical properties. It is concerned with translating users' emotions into design characteristics. The major drawback of the Kansei engineering tool is that it often generates and focuses on using adjectives which would describe the product's characteristics rather than the users' emotional states, that is, rating the luxurious feeling associated with the design. However, the Kansei engineering approach to emotional experience remains invaluable for researchers and designers to understand users' emotions and needs, which was a crucial goal of the present research.

The term emotional design and user experience (UX) was made famous internationally by Desmet et al. (2001) and Norman (2004). UX is about how users emotionally experience the world. Therefore, design for UX could explore users' lived experiences with existing products to reveal their emotions, needs, and experience of the world. However, most studies in UX still follow a similar approach to Kansei engineering to test and measure users' ratings of a product design (Schrepp et al., 2017; de Andrade Cardieri & Zaina, 2018; Pyae & Joelsson, 2018; Gayler et al., 2019).

A user starts to form an opinion about a product from the first-time interaction, which is called a first impression (O'Shaughnessy & O'Shaughnessy, 2003). The first impression grows and changes over time with long-term interaction to form a conspicuous and lucid story called user experience or UX (Norman, 2013). According to Hassenzahl (2013), the user experience process stimulates various emotional responses, which result in positive or negative consequences.

Over the last two decades, the definition of UX has expanded and changed based on its application in different disciplines (Hellweger & Wang, 2015). According to Hassenzahl et al. (2006), UX differs from traditional usability research. They argue that while usability focuses on the user on task, with an emphasis on an objective approach, UX follows a more holistic approach to investigate a user's hedonic and subjective constructions. Similarly, Arhippainen and Tähti (2003) advise that analysing users' contexts and lived experiences are significant and integral parts of the UX. The consensus on the UX concept is that it consists of three dimensions – the user's internal state, the components of the technology, and the context of use that requires empathic research that moves beyond usability testing (Hassenzahl & Tractinsky, 2006).

Empathic design research requires an understanding and compassion for users, objects, collaboration, and designing with the versatility to investigate new design inquiries and research problems (Mattelmäki et al., 2014). This shift from technological innovation to social innovation has been receiving much attention from designers and scholars (Buxton & Buxton, 2007; Hassenzahl, 2013; Cliff & Joyce, 2015; Jokinen, 2015; Lewis, 2015; Hölsgens, 2021). One of the few examples of the shift toward social innovation is the experience of sunshine and the sound of birds and nature implemented in Philips Wakeup Light (Philips, 2008). The Wakeup Light has replaced the traditional alarm system rather than improving an existing model.

Products exhibit many features that may drive users' emotions (Terninko, 1997; Desmet & Hekkert, 2007). Evaluating these features and qualities is a complex and challenging process. Some researchers have explored the 'look zones' of products, specifically fonts, graphics, and shapes (Hjelm, 2003; Johansson et al., 2003; Honderich, 2005; Dell'Era & Verganti, 2007; Karjalainen, 2007; Ashby & Johnson, 2013; Rosa et al., 2014; Kumar & Noble, 2016). Look zones can be focal points in individuals' attention for product assessment. However, these studies rarely consider if an individual had previous interaction with the same or similarly shaped products. People's past experiences will likely influence the outcome of their product assessment (Pakizeh et al., 2007). Their standards and value judgements of a product will be affected by their memories and previous interactions with the same or similar products.

Moreover, products can offer various values such as functionality and utility, sentimental and emotional values, and nostalgic memory (Kolko, 2014). They can reflect their users' personal and social personalities, such as their status, character and preferences (Asatekin, 2005). Crilly (2005) describes product values as the symbolic association of form and its representation. The acquisition, accumulation and exchange of products are very vital to the identities and relationships of individuals and determine their behaviours (Solomon et al., 2017).

Nowadays, the vast choice of products available, helped by arrays of review websites and bases to compare products effortlessly, is resulting in sophisticated users. Users do not buy only the product features; they buy the meaningful and emotional experiences a product conveys (Morrison & Crane, 2007; Zarantonello & Schmitt, 2010; Pine & Gilmore, 2011). Therefore, design practices could focus not only on the functionality of a product but also on the emotional experiences it creates for both the physical and social context of the users.

Lastly, Hutchinson and Tracey (2017) argue that in the field of user studies, not enough research has been done to understand the impact of the designers' feelings and how their feelings could affect their reasonings, actions, solutions, and design outcomes. Hence, the emotional influence of the designers could also be a point of design research and development, including how both the users' and designers' lived experiences influence the overall relations with a given product.

2.3.2. Multidimensional characteristics of emotions

In the last twenty years, there have been efforts in psychology and sociology to measure emotions (Ekman, 1993; Bradley & Lang, 1994; Scherer, 2005; Pekrun et al., 2011; Smith, 2013; Van Kleef & Fischer, 2016; Bartoszek & Cervone, 2017). In product design, researchers have established several instruments to measure users' emotional responses, whether to product designs, advertisements, or the whole user experience of the products.

Most recent studies on emotion agree on its multidimensional factors and variations in how they are experienced individually (Meiselman, 2016; Singh et al., 2021). Those studies suggest the experience of emotions will cause specific responses in users, such as physiological and behavioural. Thus, the multidimensional aspect of emotions can be better analysed and understood through a combination of methods. Jacob-Dazarola et al. (2016) categorise these dimensions into five groups of emotional processes.

1. Cognitive process

Memories, perception, attention, identification, classification, and reasoning help users evaluate whether a product generates positive or negative emotions (Chowdhury et al., 2015). A product's character is considered a cognitive structure. Cognition is closely related to emotions. The particular cognitive structure of an object can generate different emotions. For example, a simple interface of a product may represent it as easy to use, even if the user has no hands-on experience with the product (Hassenzahl, 2018). There are many well-established studies in the field of product design which explain the underlying cognitive processing of emotions (Desmet et al., 2001; Jordan, 2002; Norman, 2004; Nagamachi, 2010; Wright et al., 2018).

2. Physiological process

Positive or negative experiences can trigger physiological changes in users. Our autonomic nervous system mediates changes and reactions in our body that can be a result of experiencing certain emotions. These physiological changes can be measured through bio-signals. Studies in HCI and UX use bio-signals data to deduce users' emotional states

(Subramanian et al., 2016). The physiological process can monitor hormonal levels, heart rate, a well as circulatory and nervous systems.

Popular techniques to measure users' physiological responses include galvanic skin response (Nakasone et al., 2005), pupillary response (Chen et al., 2011), electroencephalogram (EEG) measurement (Das et al., 2013), and electrocardiography (ECG) data (Haag et al., 2004). Efforts to measure users' physiological responses such as tracking eye movements, galvanic skin response (GSR), respiration, and heart rate variability (HRV) have become progressively more sophisticated, and their level of detail and responsiveness holds much potential. However, in almost all cases, these measurements face the limitations of both confounding factors and noise.

The self-assessment manikin or SAM (Lang, 1985) and a wide range of wearable sensors created by the Affective Computing Group at MIT (Picard, 2000) are some of the earlier tools to measure expressions and physiological elements of emotions. The main factor in such tools is that they are language independence, which allows them to be applicable in different cultures without needing modifications. Another benefit of these tools is that they are less biased than other techniques. The researcher does not need to design predefined words or characters, and participants will be less likely to get distracted through the process. However, these studies are limited in evaluating mixed emotions or differentiating between emotions that might have similar physiological reactions, such as fear, surprise, and anger. Furthermore, they do not explore users' reasoning and the context's influences on their responses.

3. Thought-action tendencies

Some emotions are easily detected in people's expressions and gestures. They work as a communication network for individual intentions and actions (Desmet, 2018). Facial action coding system (Ekman & Friesen, 2003), genetic programming (Loizides et al., 2002), maximally discriminative facial moving coding system (Izard, 1979), and AMUSE tool (Chateau & Mersiol, 2005) are some of the well-established quantitative approaches in usability testing studies. These studies quantify emotions using scale techniques proposed by Ekman (2007) on recognised key expressions such as happy, sad, angry, neutral, fear, surprise, and disgust.

The PreEmo measurement tool is a famous model designed by Desmet (2005) to explore the emotions evoked by cars in Japan and The Netherlands. This study focuses on pictorial representations of emotions for assessment. The emotions are animated in two groups –negative and positive emotions. While this method benefits from being applicable to different cultures, it limits the immediate impression as participants are asked to rate 14 positive and negative emotions towards the product. It also lacks a description of the reason for the emotions elicited. I adapted this method in my previous research (Moradi, 2015), where the results suggested that participants preferred to express their emotions using positive emotions and would rate negative emotions mostly as neutral even if they did not desire the product.

4. Behavioural tendency

The behavioural tendency is related to the activities shared with the subconscious level of everyday actions, such as the continuous learning of functions and interfaces for a newly designed mobile phone. Standard techniques used for measuring users' behavioural responses include self-report, journaling and observation methods to follow a naturalistic approach to studying user behaviour in real environments (Wu et al., 2017). Other techniques include monitoring behavioural responses, task performance and usability in controlled laboratory settings (Zhang, 2014; Hertzum et al., 2015).

5. Subjective emotional experience

People vary in respect of their emotional responses. While one person might find a product desirable, another person may disapprove of it. Similarly, the same person may feel several emotions about a particular product at different times. Jokinen (2015) explains that the primary appraisal of interaction can cause different levels of emotional experiences for the user. Factors such as the importance of the interaction for the user, subjective goals and individual perspectives all play essential roles in the user experience. Studies focusing on the subjective dimension of user experience indicate that the conscious attribution of the source of perceived emotions influences users' behaviour and responses (Scherer, 2009).

The ability to elicit surprise is one component of the subjective emotional experience. Ramírez (2014) analyses strategies designers use in order to stimulate a surprise emotion to draw people's interest. Techniques include observing people's personal experiences at behavioural, cognitive, and emotional levels and then using an element of unfamiliarity or familiar attributes in a different situation to evoke surprise. Becattini et al. (2020) investigated that surprise features are crucial in creating products that can spark curiosity and attention in users. They found that predetermined expectations are also a critical component of surprise. The surprise element of design connects to the multifaceted and vast nature of emotions.

Researching subjective emotional experiences requires a systematic and long-term study to engage with the different stages of user's behaviour from prior interaction through to purchase decision-making and long-term use. By better understanding users' emotions, strategies such as embedding surprise features in design can be utilised in a meaningful way for users.

Conducting a generative session is another technique that Sanders and Stappers (2012) proposed for designing solutions by involving users in the creative process and learning from their context. This approach was designed considering the users' needs, wishes, motivations and experiences. A generative session combines different research methods and hands-on activities such as journey mapping, card sorting and prototyping for collecting different levels of information.

2.3.3. Multimodal methods of understanding users' emotional experiences

Multimodal methods provide a promising framework by overcoming the barriers of silo measurement methods and providing more robust representations of the cognitive load, which can be derived from any data source (Chen et al., 2016). Multimodal Cognitive Load Measurement (MCLM) combines physiological, behavioural, subjective ratings, and task performance-based measurements (see Figure 2.3). These methods can also be categorised into data-driven and knowledge-based measurements. Multimodal approaches have also been shown to be rigorous in measuring non-primary factors such as environmental factors, for instance, assessing luminance changes.

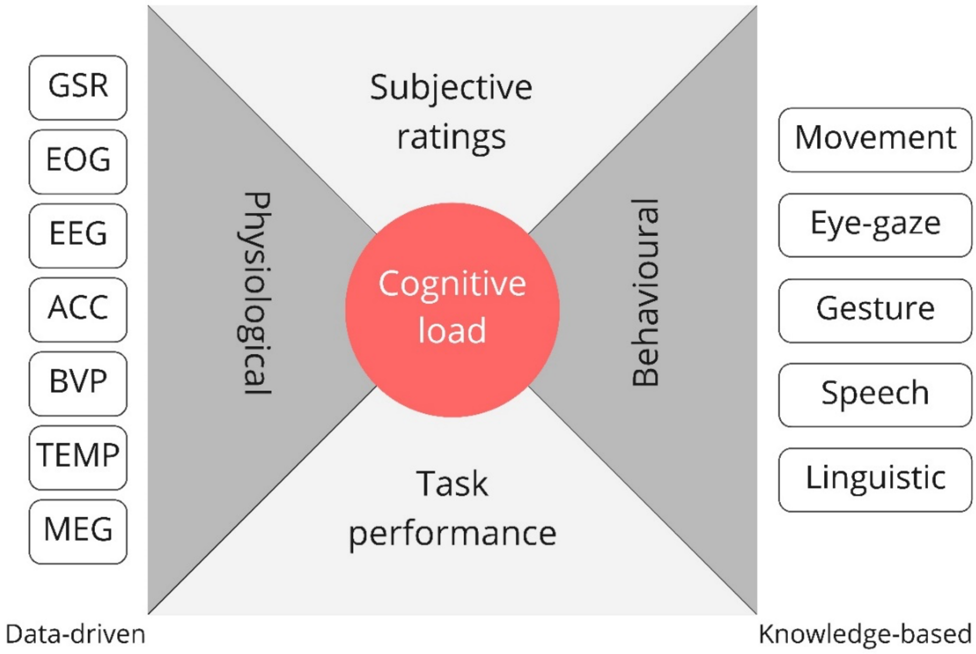

Figure 2.3. MCLM Framework (Chen et al., 2016)

Applying a multimodal approach to understand users' lived experiences enables a robust data collection for this research. MCLM can establish a link between the subjective, emotional experiences of users and their current state of interactions. However, MCLM is one of the many approaches that can inform the complex nature of users' lived and emotional experiences. It is, therefore, one tool amongst many that can be used for data collection and analysis. The present study, informed by the MCLM method, used social robots to understand and validate the different contexts of the users' lived experiences and to capture different stages of user experience that might occur over time.

2.4. Design research on active ageing users

Populations are getting older worldwide (Lloyd-Sherlock, 2000; Fisk et al., 2009), and unlike previous generations of older users, the current older users are often healthy, active, and familiar with the technology. Some older users were the first generation to experience mass media and electronic networks. They had access to education, wealth, and leisure. They also witnessed radical technological changes in their work and home environments (Haddon, 2000; Gilleard & Higgs, 2002; Brophy et al., 2015).

The focus of user experience studies has predominantly focused on millennials, born from 1981-1996 (Odom et al., 2011; Saariluoma & Jokinen, 2014; Shin et al., 2017; Yu & Nam, 2017), potentially because they are spending more money on experiences rather than commodities (Garikapati et al., 2016). In contrast, research on the ability of the older generation of users to adapt to technological innovations has often been neglected (Lee, 2017), despite them having high disposable incomes and spending patterns and experiencing increasing challenges.

2.4.1. The influence of technology on active ageing users

Smart products are rapidly being integrated into most everyday activities (Coughlin et al., 2007). Examples include booking appointments, ordering transport and food, monitoring heart rate, calculating ECG (electrocardiography), learning behaviour patterns such as sleeping time, favourite routes to work and estimating travel duration. There have been extensive improvements in technology to support older users' well-being, such as GPS (Global Positioning System) tracking, fall detection, and telehealth services (Brophy et al., 2015).

Smart products are considered to require minimal instruction and training (Kurniawan, 2008; Blackler et al., 2012; O'Brien & Rogers, 2013). However, the shift towards integrating technologies into everyday activities has caused great difficulties and frustration for some older users learning to interact with contemporary smart products smoothly (Rama, 2001; Djajadiningrat et al., 2004; Pattison & Stedmon, 2006). These challenges can reduce motivation for self-care and create a sense of social isolation and even depression for some older users (Mynatt et al., 2000; Lawry et al., 2019).

Designers can focus on creating smart products such as smart homes, smartphones, and smart cars for users' emotional and functional needs. The possibility of making a strong bond with a product such as a car that contains new extra operational options seems like a more challenging design goal when people are unaware of how to use them. AI could be implemented to understand each user, personalise the offerings and give suggestions on how to use the extra functions of the product. If applied correctly, AI and smart artificial assistants could help humanise highly technologically advanced products, that is, to make technology better able at interpreting and responding to users' needs (McStay, 2018).

There are various examples of AI and smart artificial assistants available for everyday use. For instance, the Leka smart toy[3], an interactive robotic companion, offers sensory stimulations to encourage social interaction and assist children with their learning progress. Romeo[4], a humanoid robot, is designed for research into supporting older people and those who are losing their autonomy. Intelligent assistants such as Siri, Alexa, Google Assistant, Google Allo, and Cortana can simply perform what the user wants them to do by just asking them, which can make the process of completing tasks much easier (Ward et al., 2018). Instead of going through settings, the user can directly ask the phone to complete a task for them, such as setting the alarm. However, while there is massive potential for AI, currently, it has only been applied to a limited number of cultures and societies.

Research related to the design of technology for older users distinguishes age-related changes as essential factors in the application of communication and information technologies (Bouma et al., 2007; Miller et al., 2012; Braun, 2013). The goal of most research on older users is to increase the adoption and effective use of technology (Gaßner & Conrad, 2010). Brophy et al. (2015) argue that smart products not only need to be usable and practical but also meaningful and emotionally pleasant for the next generation of ageing users. It is necessary to recognise how this diverse group of users interact and co-exist with technology. Research needs to move beyond measuring product performance, functionality, and users' adoption, toward understanding and realising the relationship between ageing users and technology.

Studies suggest that a combination of cognitive, physical, sensory, and attitudinal changes that occur due to ageing can impact older users' interaction with technology (Rogers et al., 2013). Familiarity and knowledge gained from past experiences are fundamental components of an intuitive interaction (Lawry et al., 2019). Older users interact with products less instinctively and more slowly than younger generations due to less familiarity (Blackler et al., 2010; Reddy et al., 2010; Olson et al., 2011; O'Brien & Rogers, 2013).

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[3] More information on Leka: https://leka.io

[4] More information on Romeo: https://www.softbankrobotics.com

One approach for improving the experience of complex contemporary products is integrating intuitive interaction into design practices as a shift towards a more inclusive society (Blackler et al., 2010). According to Blackler et al. (2010), it is tempting to believe that, as the population matures, users who are experienced with technologies will likewise mature, and the age-related issues will resolve themselves. However, it is more likely that the dynamic nature of technology will continue to create a disparity between the experience of older users and the new products of the day (Fisk et al., 2009). Brophy et al. (2015) suggest that the design of future products has to extend beyond the narrow focus of age-related decline. The design community needs to have a broader perspective for the envisioned future of technologies designed for older users. Designing for this space is not exclusive to supporting operational independence, but also about living experiences as they become digitalised activities like reading, listening, creating, playing, communicating, and sharing.

2.4.2. Social robots for active ageing users

Social robots, as a sub-category of smart products, have been an emerging technology of interest to promote active ageing through assistive care and social support (Robinson et al., 2013; Pu et al., 2019; Woods et al., 2021). The term ‘social’ is still a debatable topic, as the value and use of such robots are very new and still being explored (Henschel et al., 2021). Social robot use expands into various contexts of use, including domestic (Li et al., 2019), entertainment (Peter et al., 2019), elder care (de Graaf et al., 2015), hospitality (Ivanov et al., 2018), and education (Belpaeme et al., 2018).

Traditionally, HRI studies have mostly focused on quantitative and short-term approaches to data collection (Ficocelli et al., 2015; Baisch et al., 2017; Chen et al., 2020). However, recent studies have increasingly been applying mixed-methods participatory research to better analyse the open context of the environments in which the users will eventually interact with social robots (Lee et al., 2017; Van Maris et al., 2020; Ostrowski et al., 2022). Often these inquiries focus on designing social robots primarily for the benefit of healthcare providers and care homes rather than the active ageing users (Pedersen et al., 2018). With the growing interest in designing social robots for active ageing (Menezes & Rocha, 2021), the need for fieldwork and extended user research beyond the controlled environment and in the home environment context has increased. Applying fieldwork studies and extended user research in the field of HRI allows researchers to consider the complexity of user relationships with such emerging technologies and how they influence each other (Ben Allouch et al., 2020).

The role humans play in HRI research is significant, which calls for more socially engaged research within the field of HRI (Lee et al., 2022). Social robots also need to have the capacity for establishing and maintaining commitments with humans in their social interactions (Pacherie & Castro, 2021). These social capacities require analysis and prediction of diverse factors such as contextual parameters, social norms, and motivations, which are better understood through studying the context of use. It is crucial to move beyond the usability and functionality of smart technologies such as social robots to consider the influence of the context and users on the interaction (Reig et al., 2022).

All the factors influencing the relationship between users and social robots call for research and design practices that can go beyond human-centred HRI studies (Dautenhahn, 2007). Recognition of mutual learning in human-robot interaction is highly needed to achieve genuine participatory engagement in the field of social robotics (Weiss & Spiel, 2021). Nichols et al. (2021) suggest that perhaps collaborative storytelling with social robots will be the next step in the mission of going beyond human-centred design.

2.5. Research approaches

Lab-based and field research approaches are invaluable for evaluating and understanding the relationship between humans and technology. Lab-based studies are particularly important in testing whether a product meets certain predefined tasks and usability criteria in a controlled environment to reduce and regulate the costs and risks involved in the production and testing of the final product (Hertzum, 2020). On the other hand, field studies are useful for observing detailed information about the real use context and identifying the social factors that might not be visible or accessible in controlled environments (Morrison et al., 2010).

Research suggests that lab-based and field studies complement each other in the iterative process of research and design (Maguire, 2001). Each approach could provide valuable information to inform design practices depending on the different stages of the research and design process.

2.5.1. Lab-based research

Often, HCI and HRI studies relating to active ageing users consider lab-based methods of inquiry that are extensions of usability tests (Lallemand et al., 2015). A reason for this choice is the requirements and the priority for evaluation and usability testing in the healthcare and aged care sectors (Russ & Saleem, 2018; Aiyegbusi, 2020; Holden et al., 2020). Furthermore, lab-based research is easier to control in regard to variables, easier to replicate, and often less time-consuming. It can be an efficient, systematic and precise approach to testing and evaluating a system or product in a controlled environment and analysing the cause and effect relationships of the variables (Rogers et al., 2013). Standard methods used in lab-based studies of HCI include participants' ratings of products, paper or digital visualisations, or scripts and scenarios using questionnaires, rank ordering and Q-sort, think-aloud interactions, observer ratings of the interaction, one-on-one interviews, and focus groups (Mettler et al., 2017; Olde Keizer et al., 2019; Spatola et al., 2021; Reig et al., 2022).

However, lab-based research follows episodic and snapshot approaches in artificial environments. Episodic approaches cannot convey the complexity and richness of interactions between user and technology and omit to consider external context and other relevant artefacts (Turner, 2020). Research suggests that the complex nature of smart products performing a wide range of tasks and assisting people in the real world requires studies to investigate more extensively beyond the laboratory settings and mock homes or office environments (Sung et al., 2007; Baillie & Benyon, 2008; Cha et al., 2015; Cesta et al., 2016; Pripfl et al., 2016; de Graaf et al., 2017; Tonkin et al., 2018). It is essential to understand users' emotional experiences and contexts so that those factors can be included in designs that will be engaging and meaningful. In order to design a successful experience, research and design practices need to consider extended and longitudinal user experience rather than only a snapshot of an interaction conducted in a lab or controlled environment.

2.5.2. Field research

Field research in social sciences is commonly styled as ethnography, in which the researcher conducts a field study to understand, observe, and interact with people in the real world and their everyday lives (Given, 2008). Field research in HCI situates the study in the users' context to engage and empathise with users and their lived experiences (Randall & Rouncefield, 2018). There seems to be an overriding view on the field research approach being more suitable than lab-based studies for investigating the broader context and factors that influence human-technology interaction.

Some benefits of conducting field research include covering the limitations of other methods and approaches that often offer a simplistic view and analysis of the social life and context to inform design practices (Johnson et al., 2012; Sun & May, 2013; Randall & Rouncefield, 2018). It is a comprehensive approach to understanding the influence of social context on people's lived experiences as it allows researchers to capture the nuances and complexities of daily lives in more detail (Pelto, 2016; Bailey, 2018). It enables researchers to observe, experience, and gain firsthand knowledge about users, environment, events, social context, and processes (Blackstone, 2018).

However, the numbers of studies conducting field research in HCI and HRI are still relatively low. The low number is due to several limitations and complexities in the approach, such as getting access to enter users' real contexts, ethical procedures, extended timescales spent in the field, and complex contextual analysis and interpretation (O'Reilly, 2009; Rashid et al., 2015; Galal-Edeen et al., 2019; Lucero et al., 2021; Munteanu et al., 2021).

Contextual inquiry is a common field research approach in HCI. It uses practices such as interviews and observations to move beyond investigating and testing a system to understanding the users and the socio-technical aspects of the experience (Beyer & Holtzblatt, 1999). The socio-technical character of technology recognises that technology is not just an artefact made up of technological components. Rather, it is a system constructed through the interaction between users and technology and the task to achieve through that interaction (Mumford, 2006). Contextual inquiry, therefore, investigates users' daily activities and social context to better understand their everyday life and its socio-technical aspects (Karen & Sandra, 2017).

Probes are another popular approach to field research, which originated in the art and design discipline (Gaver et al., 1999). The approach looks beyond identifying a problem or need of users by focusing on the aesthetic and emotional values of their context (Crabtree et al., 2020). The probes consist of various artefacts with associated tasks such as cameras, journals, postcards, and audio recorders. Probes are user-led and aim to provoke users to explore, apprehend and document their own lives through the given provocations (Woodward, 2020).

2.6. Key considerations

Based on reviewing the literature on various theories and frameworks in the present chapter, the key considerations to analyse a user experience are – the context, user needs, and product attributes. This section discusses these factors in more detail to outline how the literature has informed the research design presented in Chapter 3.

2.6.1. Context

The contextual influences on the human-technology relationship include but are not limited to the use environment in which a user interacts with a product, the socio-cultural context, facilitating conditions, and the user's past and lived experiences (Khan & Germak, 2018). To truly understand the human-technology relationship, it is important to research and consider the context that the users are inhabiting (Pereira et al., 2020). Some of these contextual factors are reviewed in more detail in the following sub-sections.

Use environment

A product, system, or service is used in a specific technical and physical environment that could influence the user experience. In relation to human factors and usability viewpoints, it is incorrect to describe a product as ergonomically appropriate and usable without analysing and describing the context and environment where it will be used (Maguire, 2001).

In HCI and HRI studies, the tasks that users perform are often observed through usability tests in labs or controlled environments, with a growing number of research analysing the organisation or work environments (Jung & Hinds, 2018). With smart products such as robots becoming available as social, companion, and assistive technologies for use in diverse home environments, more complexities and opportunities are involved in ensuring a safe interaction between humans and technology. However, limited research has considered studying the use and interaction with social robots in home environments over extended periods (Hansen et al., 2020).

If smart products such as robots are designed to be mobile then collecting information about diverse environments and contexts of use could enable their designs to better suit, map, and locate the space and obstacles of the use environment (Nanavati et al., 2022). Researching human-technology relationships in technologically enriched environments help in identifying the environmental variables, networks and relationships between different elements and objects in space (Stephanidis et al., 2019). Researching diverse use environments could allow design practices to better align with expected actions and responses in different environments such as hospitals, workspaces, or home environments.

Socio-cultural environment

The socio-cultural environment can be defined as a social and cultural system of a nation (Anggadwita et al., 2017). It includes elements such as norms, metaphors, religion, economy, politics, beliefs and values, geography, as well as demographic differences such as ethnicity, household and family structure, wealth and social class, health, habits, gender influence, language, literacy level, and employment (McCarty, 2010).

Over the last few decades, there have been a substantial number of studies in HCI highlighting the significant influence of socio-cultural context and practices on the human-technology relationship and how they affect and shape each other (Holland & Reeves, 1994; Kaptelinin & Nardi, 2012; Sharma & Mehta, 2016; Kitzie, 2019; Zhao et al., 2020). Researchers argue that human activities and behaviours are mediated through culturally developed tools and technologies, following Vygotsky's socio-cultural theory (Vygotsky, 1978). The theory suggests that society, culture, and social interaction play a fundamental role in human intelligence, development, and meaning-making.

However, while most studies acknowledge that human and technological advancements are shaped by and will shape the socio-cultural environment, they seem to miss the opportunity to explore and analyse the socio-cultural environments beyond only stating the context of use. Conducting research beyond labs and controlled environments could analyse how the users inhabit their world and create meaning based on their different contexts. Furthermore, investigating and factoring in the socio-cultural context of a user experience can provide richer contextual results of where technology will be used (Spanhel et al., 2019).

Facilitating conditions

The extent to which an individual perceives factors in an environment and the technical infrastructure supporting the use of an intended technology or a system can be defined as facilitating conditions (Blut et al., 2022). These conditions influence use behaviour (Efiloğlu Kurt & Tingöy, 2017). Facilitating conditions include resources such as IT and assistance, timely support, help lines, product information, and user guides.

Research suggests that age can influence technology adoption, familiarity, and the learning experience of interacting with new technologies (Neves & Vetere, 2019). As a result, the facilitating conditions and support could significantly influence the 'use behaviour' of ageing users adopting new technology (Magsamen-Conrad et al., 2020). Research on facilitating conditions of smart technologies could inform inclusive design decisions and solutions and support ageing users' adoption and relationship with technology.

2.6.2. Product attributes

A product's attributes can be measured through its features, usability, performance, appeal, and task delivery (Kotler & Keller, 2021). That is, the feelings that a product can evoke, its performance, how easy it is to use and navigate, its appeal and attraction, and the tasks it delivers and how it delivers them. All these features form the basis of a product and users' perception of it. Considering the influence of product attributes on user experience could enable researchers and designers to gain a deeper understanding of a product's utility and how users experience it.

Sensory

Sensory qualities refer to the stimulation of users' senses and the sensory input such as a sense of touch, hearing, smell, or sight when interacting with a product. The sensory qualities of a product can be linked to the concept of aesthetics, that is, attaining pleasure and understanding through sensory perception (Hekkert & Leder, 2008). From this view, sensory and aesthetic experiences are different from emotional experiences. Emotions are shaped by past experiences and influenced by users' goals, expectations, and use context. However, aesthetic pleasure is a response to the sensory qualities of a product that can be explored through understanding its connection to users' emotional experiences.

Sensory qualities can contribute to various factors of interaction, including appeal, affect, usability, performance, and sense-making (Hagtvedt, 2022). They help users form a judgement on a product and the experience of interacting with it (Brakus et al., 2009). Often users can experience stronger responses to technologies that stimulate different senses, such as the engineered solid acoustic sound of a car's door closing to make passengers feel safe (Takada et al., 2019).

Users actively use sensory qualities to make sense of their interactions with products and to construct experiences (Haverkamp, 2013). Wright et al. (2018) explain the sense-making process as a combination of anticipation, interpretation, connection, and reflection that together construct an experience. Therefore, designing sensory qualities in a product is to engage what different sensory qualities represent and explore how users make sense of such qualities to construct an experience.

Semantics and affordance

Semantics refers to the symbolic qualities of products in cognitive and social contexts of use (Tewari, 2016). It moves beyond sensory elements and focuses on the meaning of products. Semantics correlates with language, communication, society, culture, metaphors, narratives, and relationships. Unlike semiotics, which exclude human agency, semantics is centred around humans (Krippendorff, 2005).

While semantics is about communication and understanding the meaning of a product, affordance refers to the perception of intended use. That is, users do not perceive technology without its potential in action. They perceive the intrinsic ability to use it (Norman, 2013). For example, a button affords being pressed, and a chair affords being sat on. Product affordance can help users understand how to use a product without any instructions (Bærentsen & Trettvik, 2002).

Although semantics relates to meaning-making and affordance to action and usability, they both shape and influence technology acceptance, perceived interaction, and the human-technology relationship. Often in the field of HCI, these two concepts of semantics and affordance get confounded (You & Chen, 2007). Therefore, distinguishing the concepts from each other could help research and design practices to better utilise and incorporate these concepts.

2.6.3. User responses

User responses are influenced by several qualities that could inform research and design of user experience of interacting with smart products. These qualities include but are not limited to visceral, social, reflective responses, and past experiences (Norman, 2004; Brakus et al., 2009). Each component on its own contributes to the understanding of use behaviour, and all of them together create a complete picture of the users' reasonings for engaging with various technologies on different levels. The combination of these qualities could examine and present users' responses not as a single outcome but as a complementary block that defines the whole user technology relationship. Conducting research that considers these qualities requires a comprehensive study of users' narratives, lived experiences and how they perceive their interaction with emerging technologies.

Visceral responses

Visceral responses are the ingrained, subjective, deeply rooted qualities that are subconscious, automatic, and almost entirely out of users' control (Norman, 2013). They are highly related to bodily experiences such as the tension in the body when in fear or stress. They are not often related to emotions as they are simply reflexes to situations without any cause assigned to them.

An example of visceral responses could be the strategic use of colour in designs that could generate different sensory responses, such as blue creating a sense of trust and calm. According to Norman (2004), many current product developments compete at offering such visceral responses, as users nowadays expect the products to deliver useable and functional products. Visceral responses are immediate users' reactions to factors such as sensory attributes, attractiveness, styling, and sentimental features (Wrigley et al., 2008).

Social responses

One of the issues raised with ageing is the negative impact of social isolation. As a result, studies are increasingly exploring the use of technology for social connectedness (Petersen et al., 2016). In the field of HCI and HRI, social responses refer to users' sense of belonging, connection, and relationship, and the influence of others on how they experience their world and technology through and with technology (Waycott et al., 2019). An example of research and design practices addressing social aspects is the design of social robots for social interaction and therapy (Wada et al., 2014).

Understanding the users' social responses and experiences could identify how technology could address social isolation, such as enhancing the sense of belonging and connectedness. Engaging active ageing users as co-creators in conversations around the meaning of social relationships, connectedness and belonging could allow design research to understand social inclusion better and identify empathic design solutions (Duarte & Coelho, 2019).

Memories and past experiences

User perceptions and experiences are shaped by combining current sensory stimuli with past experiences and memories. The human brain uses lived experiences to predict current experiences (Barrett, 2017). Users' past and lived experiences influence how they perceive and interact with their world and the objects around them, including future technologies (Aizpurua et al., 2015).

Ageing users have observed some of the most radical technological advancements over the last few decades (Čaić et al., 2019). Changes in technology have influenced their social communications, connections, work experiences, health and medical support and information, hobbies, and other day-to-day activities (Zhou & Salvendy, 2018). The effect of technological advancements on ageing users' lives and experiences could inform their perceptions and views of the future (Chandler & Lusch, 2015). Researching users' lived experiences, memories, and beliefs could gather substantial information on ageing users' relationship with technology.

Reflective responses

Norman (2013) describes reflective responses as the conscious, rational, and cognitive characteristics of thinking. Reflective responses inform users' perceptions of what it means to use and learn how to operate a technological innovation. They are linked to memories and lived experiences to make meaning and act on a current experience (Alonso-García et al., 2020). Reflective responses are evaluative and affect predictions about future interaction.

Reflective responses are linked to the highest level of engagement, relating to meanings, self-image, and expression (Aftab & Rusli, 2017). They can be understood as narrative experiences. That is when quality of a product is explored by its stories and meanings, not its objectivity and functionality (Chapman, 2015, pp. 87-112). To design for reflective responses, active participation by users in research and design practices would play a significant role in interpreting users' reflections and meaning-making.

Familiarity

Users' familiarity can be defined as knowledge and understanding of a technology based on other interactions that can be constructed through a combination of reflective, social and visceral factors and past memories (Zhang et al., 2019). Familiarity is related to but different from recollection, in that a user may be familiar with technology but not recollect the exact events and activities that helped them gain knowledge about a technology (Yonelinas, 2002).

Studies suggest that incorporating familiarity elements into the design of technology for ageing users can create inclusive and intuitive experiences for them (Lawry et al., 2019; Reddy et al., 2020; Zhang et al., 2021). Familiarity can play an essential role in developing user trust in technology and how they understand the interaction process and experience it (Tenhundfeld et al., 2019). Research on ageing users' familiarity could support the design of future technologies that positively enhance the human-technology relationship.

2.7.Research gaps

In the current technology design literature, many studies have explored the emotional experiences between users and technology (Thoring et al., 2016; Hanington, 2017; Shin et al., 2017; Desmet, 2018; Hassenzahl, 2018). Nevertheless, there are limited studies conducted in the field of HRI to investigate the emotional experience of active ageing users interacting with smart technologies such as social robots (Tallapragada et al., 2017; McStay, 2018; Tonkin et al., 2018).

With the increasing influence of advanced technologies in our everyday lives, social and ethical concerns are being raised about the designs of future technologies (Greenfield, 2017). A major concern is the design of robotics and AI systems that lack consideration of peoples' emotional and social expectations towards them (Schifferstein & Desmet, 2010; Lee et al., 2011). There is a need for researchers and designers to assess how these technologies could influence future users in transitioning from conventional products to emerging smart devices.

Current literature suggests smart products require users to learn new and multifaceted skills (Barricelli & Valtolina, 2017). The complexity of such devices has caused frustrations among some older people who are accustomed to simpler processes and the ability to manually control their products (Yang & Coughlin, 2014). There are increasing issues around accessibility, isolation and a loss of independence that comes with age, influencing how ageing users interact with technologies. Limited prior experience with emerging technologies can restrict ageing users' ability to modify device settings or tailor system preferences to meet their needs. These social issues affect not only ageing users' perceptions of technology but also their chances of accepting current and future products (Haddon, 2000; Olson et al., 2011; O'Brien & Rogers, 2013).

Concerns around active ageing users' relationship with emerging technologies highlight the importance of conducting user research beyond the lab environment. Field studies could allow researchers to further explore and empathise with ageing demographics' emotional experiences and needs. It is important to ensure that the research and design of future technologies are inclusive and meaningful for all generations of users.

The literature provided a thorough picture of the complexity of exploring the factors that influence and shape the human-technology relationship. The UTAUT theory (Blut et al., 2022) and MCLM methods (Chen et al., 2016) covered expansive accounts for understanding various elements and factors that influence and shape human-technology relationships. In Chapter 3, I reflect on these models and expand them based on literature to outline the study's conceptual framework. Throughout my research, I look at the multidimensional aspects of users' relationship with technology and conduct extended user research beyond the lab environments. I explore users' responses by looking through their emotional and mental reasoning, changes in physiological, gestural, behavioural, and subjective individual responses and lived experiences. Studying all these dimensions provides accurate data and an in-depth understanding of users' full emotional or lived experiences.

2.8.Summary

This chapter presented a literature review on human relationships with technology and design research practices in the field of HCI. It highlighted the complexity of human-technology interaction and the influence of current investigations into the emotional and social impacts of technologies and how they inform future designs.

I highlighted the importance of more inclusive design practices to meet the needs of an ageing population worldwide. I reviewed the literature on the challenges users face as they age when interacting with emerging technologies. I then explored design practices around the ageing generation of users' interaction with advanced technologies.

I compared the strength and limitations of both lab-based research and field research approaches in the fields of design for HCI.

I then examined the development of prominent user experience theories over time and the most used methods for understanding the human-technology relationship.

Lastly, I discussed the important role of emotions and lived experiences on the user experience and perceptions of technology and explored research conducted on emotional experiences.

CHAPTER 3. RESEARCH DESIGN

"As studies in philosophy and technology mature, it will be increasingly important for us to think critically about the origins and relative quality of the knowledge that we draw upon as we address the key questions. There are bound to be disagreements about which strategies of inquiry are the best ones to follow. But it seems perfectly clear that, faced with the enormously diverse kinds of technology in the world, philosophers must somehow gain a well-developed understanding of at least a representative slice of them."

- Langdon Winner *(Upon Opening the Black Box and Finding It Empty: Social Constructivism and the Philosophy of Technology,* 1993*)*

3.1. Research approach

Research questions

Realism ontology

Social constructionism epistemology

Interpretivist paradigm

Extended multimodal user research

Conceptual framework

3.2. Methods

Methods and techniques development

Pilot study

Product

Data collection process

Data analysis

Participant selection

Ethical consideration

3.3. Summary

In this chapter, I frame and justify the research design of the study. I have organised this chapter into two sections to explain my research paradigm, methodological approach, and choice of research methods. Figure 3.1 illustrates the epistemological and theoretical position of my research.

In the first section, I present my research questions based on the identified gaps in the literature. I then cover the ontological and epistemological orientation of my research to address the research question and the study objectives. I explain my reasoning for undertaking an interpretivist paradigm to investigate the emotional experience of social robots for active ageing users. I clarify the rationale for selecting extended multimodal user research as my methodology. Lastly, I present the conceptual framework of my research. My focus was particularly on capturing data and valuable insights which influence users' emotional responses toward social robots from a multidisciplinary perspective. I emphasise the need for a research approach that can help designers deliver more inclusive and meaningful product experiences.

In the second section, I describe the methods I chose for data collection and analysis. I explain the pilot study and how it informed the final design of the data collection. I then present the reasoning for selecting the specific robot and the participants' recruitment process. I outline the strategies I used to enhance the research quality of my study while considering ethical integrity to ensure the findings were trustworthy.

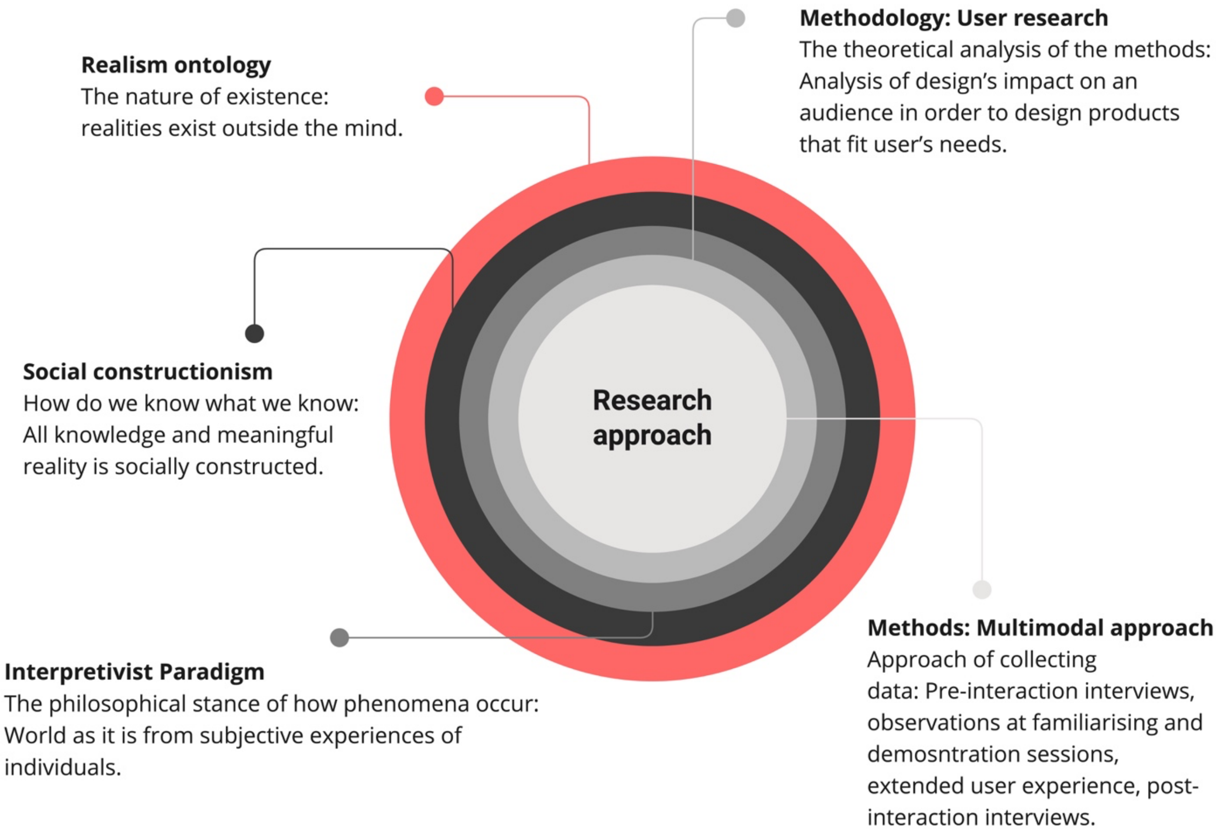

Figure 3.1. Research approach outline

3.1. Research approach

The present research focuses on a systematic evidence-based study to address the research aim and objectives of understanding the complex nature of active ageing user relationship with technology. In Chapter 2, I presented factors from the literature that influence a user's relationship with technology. Examples of these factors include the users' memory, familiarity with similar technologies, individual differences, aesthetics, and sensory elements of the designs. In this section, I present the research approach I took to look at different stages of users' behaviour towards social robots as emerging smart products to understand the role of individual beliefs, perceptions, contextual factors, and interaction behaviours on their choices.

During my research, I followed an inductive approach to explore and understand my research question. An inductive research approach is best suited when no direct precedent theory exists to support the study (O'Reilly, 2009). As a result, throughout my research, I drew inspiration from different theories and literature from related fields to develop a conceptual framework for data collection and analysis. In other words, while I did not follow a deductive approach by testing theories and hypotheses, I acknowledge the challenges and impossibility of complete openness in research practices. O'Reilly (2009) argues that all ethnography would need a framework or some level of boundaries to start research, such as conducting a literature review. Therefore, an inductive approach to research iteratively moves between theory, data collection, analysis, and interpretation (O'Reilly, 2009).

3.1.1. Research questions

My research questions resulted from an extensive process in which I explored approximately thirty candidate questions related to my study. I generated, categorised, and modified possible questions through an iterative process to arrive at the main research question of my study. I present these questions and the potential approaches suitable to study them in Table 3.1. Six of these questions were more suitable for quantitative methods such as surveys or lab experiments, and the other 24 were more appropriate for qualitative and mixed methods approaches.

My choice of research questions transpired from combining quantitative and qualitative methods that could measure user experience over an extended time. I wanted to study users' needs before an interaction, during the first-time interaction, and after familiarity over an extended period. This aligned with a gap identified in the literature; the current studies of social robots and AI machines for everyday use of ageing users need to investigate the emotional and social aspects of users' lives over extended time and beyond lab environments.

Table 3.1. My divergent thinking process of exploring different research questions to address the aim of the study

No.	Category	Research question	Potential methods
1	User experience	How might different generations of users experience automated and digitalised everyday products?	Studies of fifteen days to three months of users interacting with designs and journaling, reporting
2		How can the user experience of automated and digital products assist designers and businesses in creating emotional and meaningful values for the different generations of users?	Archival and interview with experts
3		How can the results from the user experiences of automated products be used to inform designers and businesses in creating meaningful and emotional values in developing new generations of products for the users?	Designers testing with students informed by user research studies
4		If we describe user experience as memorable and meaningful stories of use and not an immediate response, how are the users experiencing new technologies and automation in products?	Similar to No. 1
5		"An experience is a story emerging from the dialogue of a person with her or his world through action" (Hassenzahl, 2013); how is this subjective user experience influenced by the world of automated designs?	Similar to No. 1, reports of storytelling, monitoring and journaling
6		How are the users keeping up with the fast and furious changes of technological advancements in product designs?	Interview sessions
7		What are the users' suggestions to improve the user experience of automated and digital products?	Interview sessions
8	Learnability	How are the users transitioning between the user experience of manual	Changing products and monitoring over time by journaling and reporting

		and mechanical products to automated and digital products?	Different experiment sessions to observe
9		What are the users' responses toward automated products?	Monitoring and experiments
10		How are the users responding and interacting with a "smart" version of their everyday products?	Experiment sessions
11		What steps do users take to transition from the experience of manual products to automated ones?	Monitoring users in their own environment and the changes they make to adjust the new technologies to their life
12		What are the milestones for the users to transition from a manual product to an automated version?	Similar to No. 11 but more focused on the decision-making process.
13		What are the users' learning processes for working with new digital technologies and automation in products?	Setups and experiment sessions at different points. Comparison with manual designs.
14	Technology role	"If emotions are the soul of a product" (Kolko, 2014), how are the automated products delivering the emotional needs of the users? Are automated designs targeting users' emotional needs?	Focus groups, Interviews
15		How are the automated designs influencing the user experience of products?	The sociological study of the long-term effect. Journals and observations.
16		How did automation change the user experience of everyday products?	Archival research
17		While machines and automated products can bring consistency and speed, how are they doing in delivering emotional and meaningful experiences for the users?	Sociological study, Interviews and surveys
18		How are the new technologies creating meaningful experiences for the users?	Interview sessions, reports and journaling
19		What are the challenges and benefits of user experience with automated and digital products for the older generation of users?	Experiment and prototyping
20	Senses	Suppose human senses play an integral role in emotional processing, learning, and interpretation. What are the emotional behaviours of the users experiencing the automated products	Setups to add and remove sensory elements to test the difference

		with the lack of multi-sensorial elements in their designs?	
21		How does the application of multi-sensorial design influence the user experience of automated and digital products?	Similar to No. 20
22	Design process	How to design digitalised and automated products without neglecting the rich value of physical interactions?	Design and generative sessions
23		How can the evidence from user experience studies assist the design of automated and digital products in delivering meaningful emotional experiences for different generations?	Past literature and a taxonomy
24		How would new technologies be used as an enabler in designing the new generation of products to deliver emotional experiences?	Experiment and generative sessions
25		How do we create emotional and meaningful experiences for a different generation of users interacting and engaging with automated and digital products?	Focus groups and co-design sessions
26	Emotions	How would insights into the emotional behaviour of different generations of users interacting with different levels of automated and digital products inform designers and businesses to humanise technological changes?	Cross-generational survey comparisons and co-design sessions
27		What are the emotional behaviours of users in the transition from multi-sensorial and manual products to dematerialised and automated products?	Journaling and reports of people changing toward automation and wanting to use digital products
28		How are the users emotionally experiencing new technologies in products from first-time interaction to long-term use?	Different touchpoints of reports of interacting and owning a product
29		How are the users feeling about automated designs that are taking over the manual tasks?	Interviews
30		What are the users' emotional behaviours toward the dematerialisation of our physical world?	Psychophysical analysis tests and Interviews

I chose to focus on exploring ageing users' perceptions and interactions with smart products in the form of a social robot. I formulated a research question that determines the living experience of ageing users with such technologies over an extended period. I studied social robots since they are smart products increasingly being studied to address societal challenges, such as the ageing population and healthcare. Furthermore, social robots are emerging technologies that are yet to come (Liang & Lee, 2017; Robb et al., 2020; Allan et al., 2022).

Therefore, my study takes a broader view to study smart products and, even more generally, technology in users' daily lives as a way to understand the issues that will be relevant for designers of future social robots. I selected older generations of users as primary demographics. With the world population ageing, it is crucial to step away from excluded design practices that portray the field of emerging technologies only for the younger generation. I decided to follow an inclusive approach and focused on a generation that has been through the most radical technological changes and has been the least studied in this domain.

This research explores how ageing users reflect on smart products, how they interact with them, and the emotional transitioning process they go through in adapting to new technologies. I wanted to demonstrate an approach to studying the complex nature of human-robot interaction from a user experience perspective that could help designers create more pleasurable and inclusive experiences with smart products.

I formulated the overall focus of my study in the following research question:

RQ: What are the emotional experiences of active ageing users interacting with social robots?

I formulated this research question to address the overarching aim of this research that further developed into the following several interconnected sub-questions:

SRQ1: What are the experiences, challenges, and issues of active ageing users when introduced to a new smart product?

SRQ2: How may active ageing users interact with social robots?

SRQ3: What are the benefits of smart products such as social robots for active ageing users?

SRQ4: How does extended multimodal user research conducted in real-world environments support the study of complex smart products such as social robots?

3.1.2. Realism ontology

Given the focus of my research on user experiences, I identified realism as the most relevant ontological position. Ontology can be described as understanding reality and what is knowable with the nature of existence (Niiniluoto, 1999; Sobh & Perry, 2006; Pratt, 2011). Crotty (1998) and Denzin and Lincoln (2011) state realism worldviews indicate the world is there whether we, as human beings, are conscious of it or not. Realism ontology rationalises that those realities exist outside the mind (Cruickshank, 2003).

I chose realism ontology for my research as a stepping stone to delve deeper into my research question for several reasons. First, realism ontology appeared to be closely aligned with my own personal worldview and interest in understanding reality and the factors that are knowable. Secondly, I wanted to understand how users interacted with social robots and why such reactions occurred. Subsequently, I began the exploration phase of this research inspired by the object-oriented sub-branch of realism (Morton, 2013). This explorative worldview supported me in effectively retrieving data, reasonings, and consistency by not limiting my worldview to only social aspects of human relationships or human-object interaction but rather exploring the underlying dimension of all phenomena, including between objects. It served as a strategy to analyse what resides in the realm of relations between objects along with other considerations, such as time and space. Realism also offered me valuable frameworks for investigating complex social phenomena of human-object interaction and enabled me to present my "best guess" interpretation of the overall experience.

According to Morton (2013), object-oriented realism is congruent to the study of physics. He argues a universe is a large object containing other objects, such as black holes, ecosystems, and humans. Contrasting to quantitative studies that only examine the cause-and-effect correlation to impose meaning, in realism, the object of the inquiry has tangible, manipulable, internal structures, which can be presented to generate specific outcomes. Thus, I identified such a worldview as my ontology as it appeared to help with providing a rich understanding of the complex social context of human-robot interactions. I was able to enact the social phenomena of human-robot interactions by exploring the social aspects of both humans and nonhumans. Realism suggests science is a continuous process in which the researchers enhance the concepts they use to better comprehend the structures of their study (Madill, 2008). They argue that the human or nonhuman agency is constructed by social structures. Moreover, the individuals who inhabit these social structures can change and influence the actions that create such structures.

Some researchers identify realism with objectivism in epistemology and positivism as the theoretical perspective. However, if my research adopted an objectivist approach, then tackling my research question would lead me to statistical and deductive inquiries, requiring methods such as surveys, as illustrated in the work of Broadbent et al. (2018). Heidegger (2008) and Merleau-Ponty (1996) suggest a “world is always already there”, but they are far from being objectivists. Maxwell (2018) makes a clear distinction between objectivism and realism views on realities. He suggests that all different versions of realism recognise knowledge as partial, fallible, and incomplete, and theories about the world and reality are only grounded in a particular worldview. There is no denying our surroundings exist without us, as they have been there long before our presence. As Macquarrie (1972) states, there would still be galaxies, trees, and rocks even if there were no human beings. How we interpret these surroundings and make meaning out of them does not suggest that reality exists only through our understanding and our relationships (Crotty, 1998).

Recognising that a world and the things in this world exist independent of human consciousness does not suggest meanings exist separately from human consciousness. For my research, it means technologies such as smart products and, more specifically, social robots exist in time and space. They influence the social events and the actions of objects (organic and non-organic beings). However, they require human agency to give meaning to them. Through this position, my goal was to explore and gain a deeper knowledge about the social objects involved in the interaction of older users with smart products and robots. I then studied how older users define and give meaning to such interactions.

Realist researchers often claim truth is a relation between cognitive representations and reality. What humans call Matter and Nature don't exist but rather are secondary to objects. Therefore, in this study, I focused on exploring how two forms of existence, humans and robots, interact with each other and researching the experience of such interaction. I acknowledge there might be different philosophical stances suited for studying such phenomena. Most studies in the HRI and HCI tend to follow a quantitative approach to conduct research in this area (Birnbaum et al., 2016; Tan et al., 2018), where the focus of their investigation is on episodic sensory evaluation of participants. However, I believed realism could bring a valuable perspective to research in the social science domain. Through this position, I was able to deconstruct the restrictions and boundaries of the relationship between humans and technology.

3.1.3. Social constructionism epistemology

The epistemological stance of my research lies within social constructionism (Berger, 1967). It is similar to but different from the constructivist theory of knowing (Piaget, 1967) and social constructivism (Vygotsky, 1978, p. 57) in psychology.

Social constructionism is the view that meaningful reality, knowledge, and matters as such are dependent on social construction (Crotty, 1998). Meaning is constructed in and out of the human beings' communications and their human and nonhumans interactions (Elder-Vass, 2012). It is developed and communicated within a fundamentally social context. For social constructionism, there is an objective reality based on what we know of science and history. However, social constructivism believes in subjective reality and opposes objective reality and, therefore, does not align with realism ontology (Niiniluoto, 1999).

I found social constructionism suitable for understanding how older users interact with social robots, an instance for emerging smart products. It seemed most relevant to my study, given that social constructionism embraces the idea that meaning resides in the minds of individuals and is negotiated through interactions between and among them (Burr, 2015). Within my study, I focused on the construction of social robots, which served as a catalyst for exploring how the older generation of users interacting with them in the current digital era can inform the design of future products.

In modern societies, many basic human competencies have been delegated to nonhumans, such as traffic lights instead of police officers or automatic doors instead of a human concierge. Increasingly technological advancements are taking on more complex human roles, such as IoT, machine learning, and AI. Subsequently, what distinguishes our social interactions is increasingly being prescribed back to us by nonhumans. Knowledge, integrity, art and craft, power, and sociability are not characteristics of humans but qualities of humans together with artefacts and nonhumans. Each of these agents links together a part of the social world. Therefore, researching social interactions without artefacts and nonhumans would be unachievable (Latour, 1988).

My social constructionism perspective is influenced by the works of Latour (2005) on reassembling the social. Objects have agencies too, and in the post-industrial and technological era, most social actions are influenced by or are the direct work of objects (Winner, 1980). Therefore, constructing the older users' interaction with 'social' robots, as the name social suggests, has even more reason to be explored from the social science point of view. From this point of view, objects can also shape or constrain human decisions, actions and meaning-making of the world (Cowan, 1983). Therefore, society and technology are not two distinct scenes to be explored separately. They are intertwined together that provide a rich diversity of agencies. This approach enabled me to focus on better understanding the interaction between older users and social robots and the level of symbiosis that can be achieved with or through their interaction.

I acknowledge there are other worldviews worth exploring, but they might best be suited in future studies once there is more clarity around this research area. Research studies based on statistical generalisations are more suited for testing and explaining large causal relationships between social categories such as gender, race, and social class to inform social trends and cues (Cabibihan et al., 2013; Anzalone et al., 2015; Liang et al., 2017). Such approaches tend to start with a hypothesis based on existing theories and take more of a positivist stance toward the phenomenon. They do not provide interpretations of social situations that are not statistically generalised to a universal conclusion (Gaudet & Robert, 2018). Therefore, I found constructionism best suited for answering my research question and guiding my interpretation process of understanding the interaction between active ageing users and social robots.

According to Crotty (1998, p. 63), social constructionists are both realists and relativists. Saying meaningful reality is socially constructed does not mean it is not real. Sociologist Elder-Vass (2012) has a similar philosophical positioning that suggests constructionism in epistemology is perfectly compatible with realism ontology. Thus, my epistemological approach for this study is social constructionism, which suggests that knowledge and meaningful reality are socially constructed (Burr, 2015). According to constructionism, meanings are not discovered or created; they are constructed. This means objects exist with different potential meanings, but it is the social interaction between them and users that construct meanings through their experiences (Hunting, 2014).

3.1.4. Interpretivist paradigm

Theoretical perspective or paradigm is the distinct set of theories, concepts, and thought patterns that inform a methodology. They provide a framework for the process of grounding reasoning and research criteria (Creamer, 2018). To reach the objective of this research and address my research question, I took an interaction-centred perspective (Forlizzi & Battarbee, 2004) while having an interpretivist lens to explore active ageing users' interaction process with social robots.

The nature of the complex social context of active ageing users' interaction with social robots is still in the early stages of being defined and does not have set boundaries. Through this approach, I used UTAUT (Blut et al., 2022) and MCLM (Chen et al., 2016) frameworks to guide my interpretive research process tentatively. My goal was to observe older users' perspectives, patterns, and the interactions between them and the robots to understand and then interpret the situation. As a result, my interpretations helped produce meaning in an area that could also facilitate other similar situations and research.

According to Cohen et al. (2002, p. 21), an interpretivist paradigm is an approach to understanding social phenomena and the world of experience. Therefore, I considered the interpretivist paradigm aligned with realism in ontology and constructionism in epistemology. The interpretivist paradigm has several unique advantages (Elliott & Timulak, 2005; Schwartz-Shea & Yanow, 2013; Thanh & Thanh, 2015). First, it helps the theory construction in areas with no or inconclusive a priori theory, such as research in HRI. Second, it is also suitable for investigating context-specific, distinctive, and unique occurrences or experiences such as the process involved in the older user-robot interaction. Third, it helps to uncover noteworthy and appropriate research questions and matters for follow-up inquiry. It is very pertinent for the exploration of hidden reasons behind the complex, correlated, or miscellaneous social processes and experiences, where quantitative evidence may be biased, inaccurate, or difficult to obtain. Throughout my research, I presented many studies in the domain of HRI. However, most of them investigate the situation from a quantitative and statistical perspective.

My interpretivist lens on human-robot interaction could be similar to the autoethnographic method, which argues for the subjective position of the researcher by relying on a reflexive approach (Chang, 2008). However, it is different in the sense that subjectivity, human behaviour and the social aspect of the interaction are not substantive to the research. My goal was to offer my observed reality as an alternative perspective and not the only truth to the experience.

According to Latour (1988), authors and researchers can represent themselves in their scripts. Throughout the research, I followed this operation by positioning myself as the author of the text and avoided presenting a vague picture by displacing and separating myself from the text and not choosing to include a narrator. By using the first-person narrative, I aimed to present the objectives and my subjective meaning-making of the process, sensemaking of data, and data visualisation process, aimed at providing a level of self-awareness (Rapp, 2017). This approach helped me to reflect on my own experience during the course of this thesis.

3.1.5. Extended multimodal user research

Having read the literature on constructionism (Crotty, 1998; Creswell et al., 2003; Teddlie & Tashakkori, 2003; Somekh & Lewin, 2005; Bhattacherjee, 2012; Mayoh & Onwuegbuzie, 2015; Edmonds & Kennedy, 2016), I decided on user research (Schumacher, 2009) as an overarching methodology. User research aims to contribute to knowledge by understanding the impact of design on users' perceptions and responses (Kuniavsky, 2003).

User research is an "ethnographic approach" to gathering information about the event as it combines interviews with a study of users' behaviour in an everyday context (Schumacher, 2009). It enables the researcher to immerse in the experiences, which assists in better interpretation (Hunting, 2014). Therefore, I decided to study participants in their homes and the context of their everyday lived experiences. Most inquiries in HRI engage with episodic and lab-based studies of user experience, using practices such as questionnaires and focus groups for understanding emotions (Broadbent et al., 2012; Hyde et al., 2015; Johanson et al., 2019).

I chose to conduct extended user research to capture participants' initial interactions and allow users to have time and space to familiarise themselves with the robot. This stage aimed to identify changes in their behaviour, provide insights on patterns and relationships, and collect more organic feedback on the user experience. By applying an extended user research inquiry, I was able to immerse myself, as the researcher, in the user-robot interaction. I managed to fully explore the event and the social actors involved in the experience. This approach was an effective way to understand users' emotions, beliefs, and physiological and psychological responses that occurred before, during and after interacting with the robot over an extended period in their home environment.

I initially chose to conduct the extended user research over a four-week timeframe. However, after consultation with the Auckland University of Technology Ethics Committee (AUTEC) and piloting the timeframe, the decision changed to reduce the timeframe to two weeks. This decision was due to ethical consideration of participants' time and effort. Also, the pilot study showed that two weeks provided sufficient time for demonstrating and familiarising participants with the given robot and allowed enough time for reflection. However, different studies might require longer or shorter periods due to the complexity of a given project.

3.1.6. Conceptual framework

The field of design is intrinsically interdisciplinary. It is informed by social science, cognitive science, computer science and art. Interaction designers are learning the mechanics of games from video game designers, and ethnographic researchers are following the path of anthropologists (Cash, 2020). Following an inductive research approach, the selected framework of my study has adapted different disciplines' frameworks into a user research approach.

I utilised and expanded on theories and techniques of user studies proposed in the fields of design, HCI, and information systems. By adopting an interdisciplinary framework, I was able to consider factors such as understanding the technologies involved in available robots and the level of curiosity and creativity of users in interacting with a new device. It allowed me to focus on the context of experience and users' responses while also considering different aspects of technologies, such as physical attributes and semantic values.

Informed by literature from different disciplines, I followed a holistic assessment of users' lived experiences, behaviours, and relationships with technology. The holistic approach allowed me to investigate the emotional experience and meaningful aspects of social robots for active ageing users. According to Desmet et al. (2007), the main advantage of a holistic approach is creating a unified concept, which aligns appearance and interaction to create a comprehensive, meaningful experience.

I used an approach where every data collection step provided supporting information for the next. I focused on using a process where a considerable amount of the design process is spent on empathising and understanding the situation (Waidelich et al., 2018). This approach enabled the collected data to be in-depth, resulting in a better understanding of the human-technology relationship.

The selected framework of the study was an adaptation of two different frameworks of MCLM (Chen et al., 2016) from the field of computer science and UTAUT (Blut et al., 2022) in the field of information systems. I utilised these frameworks in relation to user theories and design literature that consider different aspects of users' lived experiences. It informs the study to consider user and technology attributes such as memories, meaning-making, social and emotional factors, sensory, semantics, and affordance attributes.

The criteria I derived from MCLM included considering multiple techniques in data collection. It included techniques such as journaling and interviews to understand users' subjective ratings, observing behavioural responses such as body language and signals while also monitoring users' physiological responses, such as heart rate, during the interviews and interactions. Combining multiple techniques allowed me to better reflect and interpret the complex and multimodal nature of users' emotional experiences.

Three-stage interactions

I considered studying different factors that influence the relationship between active ageing users and social robots through three stages–pre-interaction, extended interaction, and post-interaction. The decision was informed by reviewing the literature to first study users' lived experiences prior to an interaction. The extended interaction would involve familiarising users with the product, observing the first physical interaction, and allowing users to test, spend time with the product, and form their opinions without being observed. Lastly, a post-interaction stage would be to observe the overall experience and to let participants share their reflections.

Pre-interaction

During the pre-interaction stage, I focused on capturing individual beliefs and perceptions of technology, contextual factors, and facilitating conditions such as performance and effect expectancy through interviews. I used UTAUT theory as a guide to shape the interviews and different factors to consider.

Extended interaction

In the second stage, I aimed to study the first interaction between users and robots. I wanted to observe participants' physiological responses such as facial expressions, body language and heart rate. Incorporating quantitative measurement in the observation process would authenticate the data collection by comparing people's attitudes and verbal cues with their physiological responses.

I then intended to conduct an extended interaction between users and robots. I considered using the journaling method for this stage to allow users to capture their reasonings and decision-making process in their own time. My goal for this stage was to study participants' hedonic motivations and sentiments, which influence their behavioural intentions toward the interaction. As a result, I considered studying both participants' comments about how they felt and my own perspective based on observing the relationship between them and social robots.

Post-interaction

Lastly, the focus of the post-interaction stage was to look for participants' subjective ratings, points of view, and stories to capture their final evaluation of the robot. My aim for this stage was to observe users' familiarity with the robot after an extended interaction and capture their thoughts around emerging technologies that could help the ideations and designs of future products.

Figure 3.2 illustrates how these methods and key considerations from the literature highlighted in Chapter 2 support my study in exploring different factors that can contribute to the active ageing users' relationship with technology. The MCLM method collects several modes of data to ensure data reliability and better sensemaking. MCLM model is best suitable to guide the observation of users' interaction with a product. It provides a robust process of collecting and analysing users' instant, reflective and subjective responses. The UTAUT model informs conditions and attributes that impact user adoption and the use of new technologies. It provides a comprehensive guide for considering the contextual, behavioural, and conditional factors to explore and have conversations with users to learn from their lived experiences.

The framework supports a more inclusive approach for users as they have access to a multimodal approach that allows them to use some methods over others that suits them. For example, some users might be better at articulating their thoughts using journals, while others might be more comfortable verbally sharing their thoughts during interviews. Furthermore, collecting physiological responses can enable the researcher to identify emotions such as excitement at the interaction or nervousness, which could be missed during the observation process. In the next subsections, I provide full details of the methods I used for the study and the data collection process.

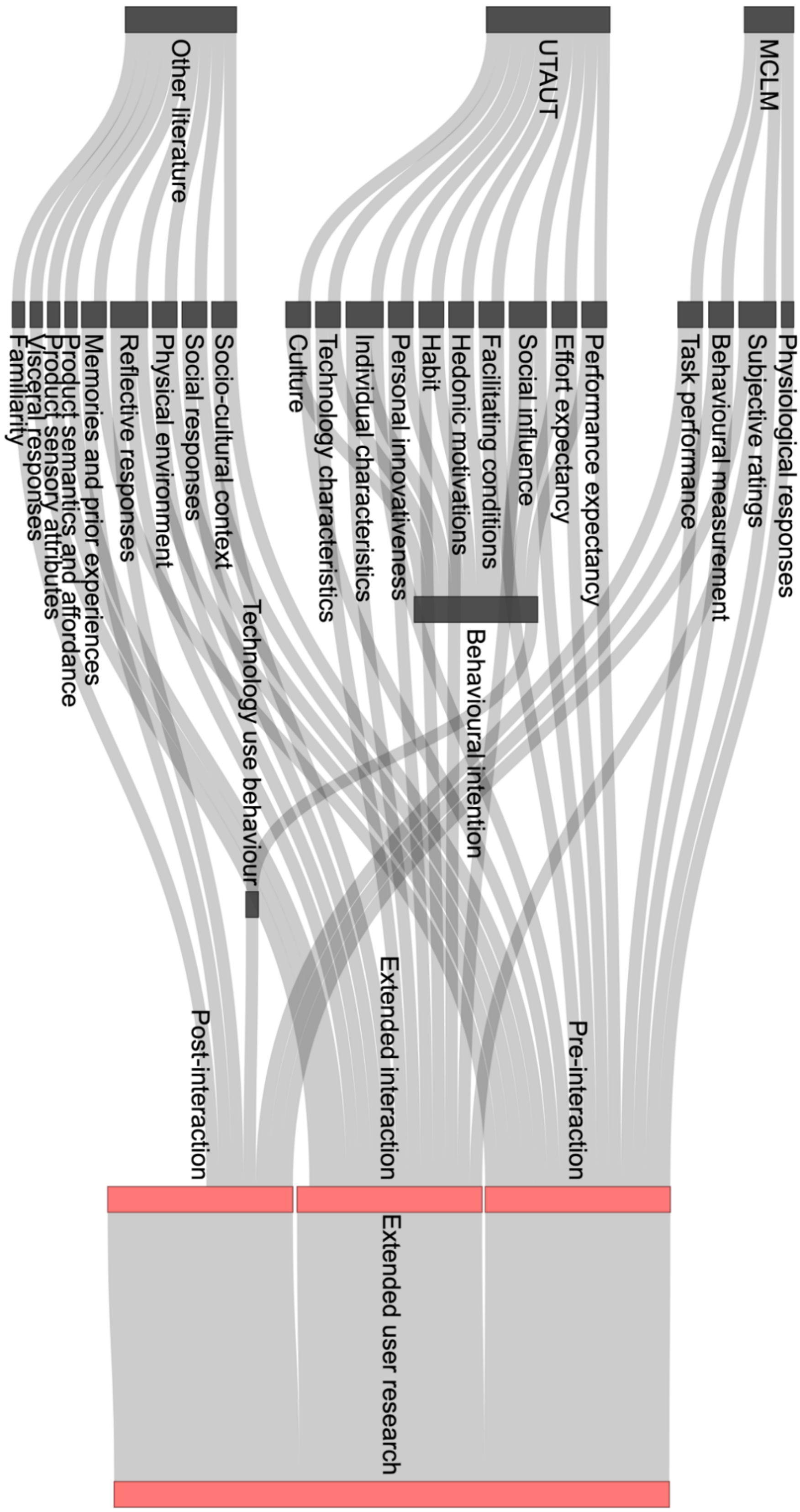

Figure 3.2. Framework for data collection (based on UTAUT and MCLM frameworks)

3.2. Methods

In this section, I explain the methods and techniques that I used in the study. I describe the pilot study and the information gained from it. I then expand on the product selection process for the study, the rationale for the selected robot, the data collection steps, and the analysis process. I give details about the participants' selection and the ethical consideration processes of the research. Lastly, I present a full detail of the data collection stages and data analysis approach.

3.2.1. Methods and techniques development

I applied a multimodal approach to data collection. This approach enabled me to collect and present data from a multitude of users' viewpoints. It allowed me to understand users' emotional needs and experiences deeply. A multimodal approach is more inclusive and holistic than studies that use one type of data collection (Hoffman et al., 2016; May et al., 2017). Following a multimodal approach, I extended the traditional lab-based usability tests by going beyond conventional observation or survey methods.

I used three main methods of data collection: interviews, familiarising and demonstration sessions, and extended user experience. I combined traditional design tools, such as interviews to identify what participants think and say, with observation techniques to collect users' physiological and behavioural signals when interacting with the product. I used the self-report user experience method to monitor users' experiences of interacting with a robot over two weeks. Figure 3.3 illustrates the overarching methods that informed the data collection process. Later, I explain how these approaches were used at different steps of the data collection to inform and link to the next step.

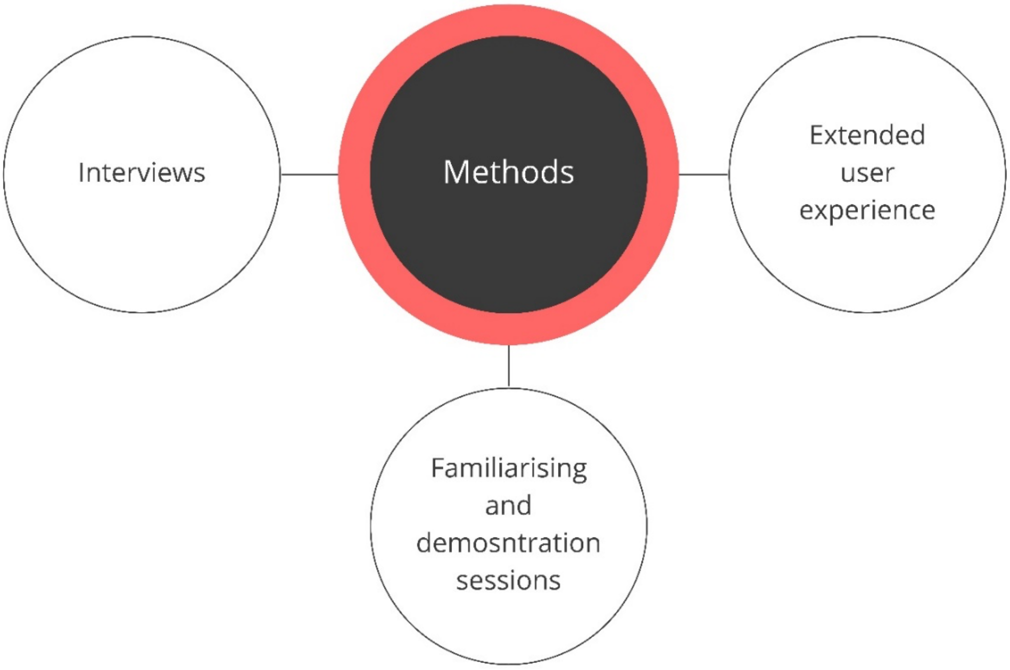

Figure 3.3. Methods used for data collection

Interviews

Interviews are commonly used in qualitative research (Fontana & Frey, 2000). They are effective tools for examining and researching the lived experiences of target groups (Liamputtong, 2010). Interviewing is a dynamic process in which participants' lived experiences are discussed and examined, creating meaning between the researcher and the participants (Liamputtong & Ezzy, 2005; Roulston, 2010). Interviews can be enhanced by using other objects, such as images or icons, to elicit stories that might be difficult to extract from a verbal interview alone (Kara, 2015). I chose the semi-structured interviewing process to allow flexibility and to facilitate participants in freely sharing their experiences (Brinkmann & Kvale, 2018). In semi-structured interviews, the researcher is still responsible for deciding what is important and the types of questions to find answers (Arksey & Knight, 1999, p. 89).

Interviews are conversational partnerships that significantly influence the process of interviewing. When participants share their experiences and expose information about themselves, the researcher needs to be understanding and empathic (Rubin & Rubin, 2005). I followed the principles of the conversational partnership for the interviewing process with an awareness of the effect my behaviour and actions have on the quality of the exchanged information. By respecting the participants and being fair and sincere about my intentions of collecting the information, I ensured participants were happy with the process and felt protected and comfortable during and after the interview. I made sure to respond to any questions they might have had about the research and answer some of the same questions about myself that I posed to them.

I audio and video recorded the interviews with the permission of the participants. Recording the sessions helped me document the specific comments mentioned in the conversation and revisit them if necessary. I was responsible for identifying the interview questions. The questions were aspects of the issues that I consider focusing on them. Moreover, even during the interview, I could narrow down the general focus of the issues discussed.

Familiarising and demonstration sessions

My focus for this part was to introduce the robot to participants and familiarise them with it while observing and exploring participants' first physical interaction and post-interaction experience in a natural environment. I explored the way participants understood and interacted with the robot based on the form, signals and symbols of the design. Gonzalez et al. (2017) argue that observing every single participant's interaction with a product offers a comprehensive and intuitive understanding of the experience. It facilitates the chance to perceive the user-product interaction as it is, without the researchers getting involved or affecting the process by implying their perceptions.

These sessions were different from the usability testing methods. According to Sonderegger and Sauer (2010), usability testing is one of the most well-known methods for evaluating the design of products by stimulating the user experience of interacting with products under controlled conditions. Since I framed my study around understanding the current emotional experiences of users prior to the design stages, I did not prototype a product for evaluation. Instead, I decided to select an existing robot available in the market to allow for reflection on the current technologies and exploration of possibilities of what future technologies could be. These sessions are fully explained in the data collection sub-section further down this chapter.

Extended User experience

One of the essential elements of user-product interaction is the temporality of the experience (Karapanos, 2012). In an earlier study, Karapanos et al. (2010) presented a conceptual model for extended user experience studies. They suggest a four-week timeframe can present the transition of users' experience in the adaptation phase of the product. Their study proposed that users' familiarity, functional dependency, and emotional attachment increases over time. An extended research can measure the level of excitement and overall evaluative judgement of users across time.

I used a journaling technique to capture users' reflections on the interaction process. While journaling requires a good level of commitment from participants, it is a valuable resource for capturing their personal experiences comprehensively (Kenten, 2010). Inspired by the approach of Bartlett and Milligan (2020) on how to use the diary method to analyse social life experiences, participants used traditional solicited diaries to record their daily expressions, emotions, feelings, thoughts, and reflections.

3.2.2. Pilot study

Before starting the actual data collection process, I ran a pilot study of the data collection process to make sure the designed interviews, journals, and familiarising and demonstration sessions were suitable for participants. Four volunteers from AUT staff and friends took part in the pilot study. Two of the volunteers were aged 65+ years, and the other two participants were in their 30s and 40s. One of the participants was male, and the other three were female. Their nationality were New Zealand, Pacific Islands, and Iran. I intentionally looked for a diverse group of volunteers to identify any contrasts in how the data collection process could be perceived. Volunteers evaluated whether the experience, the robot, and journals were easy to engage with and if they could address the interview questions I had in mind without confusion.

Based on the feedback I collected during the pilot study, I changed the order of the interview questions to start with broader questions and to leave the specific questions around companionships and relationship preferences to the last. The reason for this change was to ensure participants had enough time to engage with the study's topic. The other suggestion was to move the demographic questions to post-interaction interviews as these were the least essential questions. This change allowed building trust between participants and me by establishing a conversational relationship first. It helped participants to freely speak their minds and understand they only need to answer the questions they feel comfortable with and reject the ones they consider too personal.

3.2.3. Product

I selected Vector[5], a social robot for adults and older demographics to use in homes originally designed by the US-based start-up Anki now acquired by Digital Dream Labs. I made this selection through an iterative process. I started exploring different robots available on the market, such as PARO therapeutic robot[6], Nao[7], Sphero BOLT[8], and Cozmo[9] (see Table 3.2).

Early on, I decided against PARO due to its high cost (approximately USD 6000) and limited interactions. I ran pilot tests with some educational robots, including Sphero BOLT and Cozmo. While most seemed creative stimuli for curiosity and learning, they were more suited for research on younger generations. They also required participants to primarily interact with the robot through an app on a tablet or a smartphone, which I believed could present some barriers to social interaction between the user and the robot. Lastly, during my experiments with Nao robots, I observed some challenges with their lack of portability. A portable robot could allow participants to move and test the robot in different settings more easily. I was also aiming to present a non-humanoid and non-animalistic-looking robot to participants. I wanted

[5] Further information about Vector: https://www.digitaldreamlabs.com/pages/meet-vector and https://youtu.be/Qy2Z2TWAt6A

[6] Further information about PARO: http://www.parorobots.com/

[7] Further information about Nao: https://www.softbankrobotics.com/emea/en/nao

[8] Further information about Sphero Bolthttps://sphero.com/

[9] Further information about Cozmo: https://www.digitaldreamlabs.com/pages/meet-cozmo

to emphasise participants exploring the possible human-robot interaction beyond their familiar context of human-human and human-animal interactions.

Table 3.2. List of investigated social robots for the study

No.	Name of the robot	Company	Year	Category	Features and abilities
1	AIBO	Sony	1999	Robotic pet	Model: ERS-1000. Cloud-based AI. Recognises and remembers faces and voices. Adaptive and unique personality based on interactive learning. OLED display eyes that blink and close. Capable of performing mapping, SLAM, and obstacle detection. Self-charges when low on battery. Detects smiles and words of praise and learns new tricks. Responses positively to being petted. Size: h 29.3 cm x w 30.5 cm Weight: 2.2 kg
2	PARO	AIST	2004	Therapeutic robot	A therapeutic robot for medical use in hospitals and nursing homes. It cries for attention and responds to its name. The voice is sampled from real baby harp seals. It is covered with white antibacterial fur and equipped with an internal heating system that keeps its body warm. Size: h 16 cm x w 57cm Weight: 2.7 kg
3	Nao	SoftBank Robotics	2008	Interactive humanoid robot with personalisation	A small humanoid robot designed to interact with people. It is used mostly for research and education. It is packed with sensors and characteristics. It can walk, dance, speak, and recognise faces and objects. Size: h 58 cm x w 31.1 cm Weight: 5.5 kg
4	Jibo	Jibo Inc.	2014	Social robot	An expressive and emotive robot with face and voice recognition. It has a sensor to pick movements. It dances and has an amiable auditory response. Equipped with “apps” (called skills), allowing it to take pictures, set timers, play games, and more. Size: h 28 cm x w 15.2 cm Weight: 2.7 kg
5	Buddy	Blue Frog Robotics	2015	Assistant and companion robot	An engaging companion robot with personality, targeted for seniors that live alone at home or in an institution, to watch over them, interact and socialise with them. It comes with multiple sensors, omnidirectional and unidirectional microphones, touch screen. It hears, sees, moves, responds to touch through caress sensors, recognises emotions, communicates, and talks. Size: h 56 cm x w 35 cm Weight: 8 kg
6	MUSIO	AKA Intelligence	2015	Learnable AI robot	An educational, social robot that can hold conversations about different subjects. It answers a whole range of questions and has inference abilities. It can recognise what a person is talking about and remember past questions. It provides learning opportunities from various educational materials, especially in teaching English. Size: h 21.8 cm x w 17.4 cm Weight: 0.85 kg
7	ELLI•Q	Intuition Robotics	2016	Companion robot for active ageing	Medical companion robot with an emphasise on well-being and mindfulness that checks and monitors general health-related measurements. It offers physical exercises and cognitive games, streams music, and covers news, sports and weather forecast. It holds conversations, tells

					jokes, and allows messaging family and friends. It comes with a tablet, camera, and body that all can be placed on its charging base. Size: h 21.5 cm x w 12.7 cm Weight: 3.5 kg
8	TAPIA	MJI Robotics	2016	Fun and gamified robot	Egg shape robot with an LCD screen as its face to express emotions and show the tasks being operated. It has scheduling memorisation, sleep tracker, music streaming, alarms system, machine learning, IoT home control, movement and voice analysing systems, and user recognition. It can take photos and videos and sends them to the selected contact when commanded. It covers weather forecasts and news, holds conversations and expresses emotive responses. Size: h 25 cm x w 12.4 cm Weight: 2.5 kg
9	Cozmo	Digital Dream Labs (formerly Anki)	2016	Fun, animated, Pixar-inspired robot for children	Educational toy robot. Unique personality and voice. Comes with three cubes to interact and play games with and a “Home” charger. Need to interact with its functions through its app that can be installed on smartphones or tablets. Built-in camera, sensors, a gyroscope and a downward-facing cliff detector. Teaches basic coding. Size: h 6.9 cm x w 10 cm Weight: 0.46 kg
10	Kuri	Mayfield Robotics	2017	Home robot	designed to interact with people and capture clips of the day. It has an expressive personality and unique robot language. Autonomous navigation, HD video recording, dual speakers for play from the audio library, four-microphone array for voice detection, and dancing skills. Size: h 50 cm x w 30 cm Weight: 6 kg
11	Vector	Digital Dream Labs (formerly Anki)	2018	A social robot for adults	Designed as a robot companion and helper for people at home. Integrates with Amazon Alexa and turns into Alexa mode when commanded. Answers questions using speech recognition and synthesis. Has an expressive LCD face to respond to and engage with users. Creates maps using single-point laser and navigates using SLAM. Convolutional neural network running on board for people detection and other tasks. Unique robotic voice to respond. Dances to the music. Play games. Comes with a physical cube that acts as its toy. Sets alarms and timer, take photos, and weather forecast, respond to being petted, and follows the voice direction. It can self-charge by driving back to its “Home” charger. Size: h 6.9 cm x w 10 cm Weight: 0.39 kg
12	Sphero BOLT	Sphero (formerly Orbotix)	2018	Mechanical coding programming robot	Advanced coding robot in a shape of a ball. It provides the opportunity of learning how to code and express inventive ideas and experience the power of programming. It allows displaying custom graphics and real-time data with an 8x8 programmable LED matrix. It is equipped with advanced sensors that can be programmed and used to learn more about robotics. The app allows to create and access educational games and learn how to code through hands-on play and STEAM activities. Designed for ages 8+. Size: d 7.3 cm Weight: 0.2 kg

Vector is a small-sized product making it suitable for an extended user experience study as it can be set up and carried around by users easily. The company claims Vector stimulates multiple senses in a fun and entertaining way. The robot is approachable and not threatening due to its non- humanoid design, small size, and unique and childlike sounds. The physicality of the robot and the use of a physical cube (Vector's toy) rather than interacting with users through a digital interface seeks to engage the users in a multisensorial approach. This involvement of different senses during the interaction was one of the other reasons for selecting this social robot. It had all the attributes for exploring how sensory elements could influence users' emotions and experiences. It also had Alexa[10] embedded in it, which helped participants compare two different modes of conversational agents in the robot. Figure 3.4 presents Vector and its accessories, which were given to participants for the two-week extended user experience.

Figure 3.4. Image of Vector robot with its accessories (author's photo)

[10] Further information about Alexa: https://www.amazon.com/b?ie=UTF8&node=17934671011

Table 3.3 provides an overview of the criteria for analysing and selecting the robot for the study. I framed these criteria based on reviewing the literature to ensure different offerings of the robot could engage users in the various attributes of the human-technology relationship. I presented how Vector addressed almost all the criteria to some degree, which led to choosing it over the other models. It is important to note that some robots were better suited in some aspects, such as PARO or Jibo, explicitly designed for the ageing demographics. However, they did not cover Vector's diverse range of attributes.

Table 3.3. The criteria for selecting Vector as the social robot to use for the study

No.	Criteria	Relation to Literature	Vector
1	Sociability	Engaging users with social robots to explore their socio-cultural context and social responses.	Vector talks, has emotive reactions such as a purr-like sound when being pet, snores a little when asked to go to sleep, gets mad or excited when being picked up, dances to the music, and remembers names based on face recognition.
2	Usability and ease of use	Usability and ease of use. Ensuring the robot would work with minimum disruption during the extended user experience in a home environment. Users can set up and explore different aspects of the robot without the researcher's presence.	Vector comes with an easy step-by-step setup both provided in the manual and the app that is free to install on smartphones or tablets, it is self-charging, it has one button for switching on and off or activating voice recognition if needed instead of calling the robot
3	Several sensory attributes	Sensory elements engage users in meaning-making, perception, and emotive interactions	Vector responses in various sensory modes, including sound, vibration, and reacting to touch. It has a digital expressive face and a cube to play physical games with and through the cube. It responds to sounds and movements.
4	Portability	Moving and placing the robot in different home environments required it to be portable and easy to carry. It allows users to move them to different settings and environment	Vector is small and lightweight. It only requires its home base to be plugged in and connected to the Internet for information gathering and processing
5	Affordability	The study's budget required scoping the search down to affordable robots. Exploring off-the-shelf and social robots available for mass users.	Vector is an affordable social robot compared to robots with similar offerings. It costs less than USD 250
6	Gamification and entertainment	Active ageing and playful technologies that do not seem overwhelming or too serious. Engage and encourage users to test different elements of technology through entertaining activities.	Vector can play Blackjack with users. It plays by itself with its cube. Users can ask Vector to use its forklift to move the cube around, bring it to them, roll it, pounce it, or do a wheelie
7	Non-humanoid and non-animal like	To minimise visual comparison between a social robot with living social companions such as humans or pets. Exploring the potential of robots beyond mimicking existing social relationships and how users perceive new forms of social companions. Exploring the literature on the gap between what are the meanings of social robots currently in research and science and what	Vector has an animated look and is almost science fictional, looking similar to *Wall-E* animation by Disney Pixar. The company collaborated and consulted with a team of designers from Pixar to create the first Model, Cozmo, which is what Vector's look is based on.

		users think about them based on other constructs such as fiction.	
8	Assistive offerings	Robots can offer tasks beyond social companionships, such as communication with others, healthcare support, and assisting with daily tasks such as placing orders, cleaning, timers and reminders.	While Vector is not an assistive robot, it does provide offerings. It answers questions about worldwide events, gives weather forecasts, and takes photos. The camera can be set as a security camera for recognising movements and sending alerts to users' smartphones. It can set timers and reminders.
9	Designed for adults and older users	Robots that are specifically marketed for older users and are more suitable to address their needs.	Vector is marketed for adults, but not necessarily older users.
10	Mobile and movable	The mobility of social robots could allow exploring the opportunities and challenges that come with robots navigating the open context of use. Mobile robots allow for more natural companionship, where they do not sit on a desk or fixed context but engage with users and their context by moving around and following them.	Vector is a mobile robot. It has sensors at the front and back that detects heights and obstacles. It uses its cube as a landmark for exploring the surroundings. It does go to its home base to charge itself or if asked to "go to sleep" or "go home" by users.
11	Connection to other smart devices	A robot that can connect to other tools and apps to engage users reflecting on smart technologies beyond social robots. Support reflections and conversations around the growing potential of IoT and connectivity between devices.	Vector has Alexa embedded in that can be used if users wish to connect and log in with an Amazon account. While Alexa is not available to the full extent of Echo, it provides further offerings to users and can introduce them to experiment with more smart technologies. The robot connects to users' smartphones to provide information about Vector's offerings, support and guidance. It also provides a brief description of what Vector is doing in a written banner to unpack the actions that might seem abstract to users. Photos and recordings can be shared through users' phones to save or delete.

3.2.4. Data collection process

As presented in Figure 3.5, my data consisted of pre-interaction interviews, familiarising sessions, two-week extended user experiences, post-interaction interviews, and demonstration sessions. The circular nature of the data collection indicates my iterative process with different participants. By familiarising myself and reflecting on each participant's data, I was able to modify and improve the data collection process. The main changes were more detailed interview questions to clarify key points and adding more demographic questions to the second interview to create time and space for participants and enable me as an interviewee to build rapport and trust. I conducted the data collection process by interviewing the first participant on 8/5/2019 and finished the last data collection on 20/3/2020.

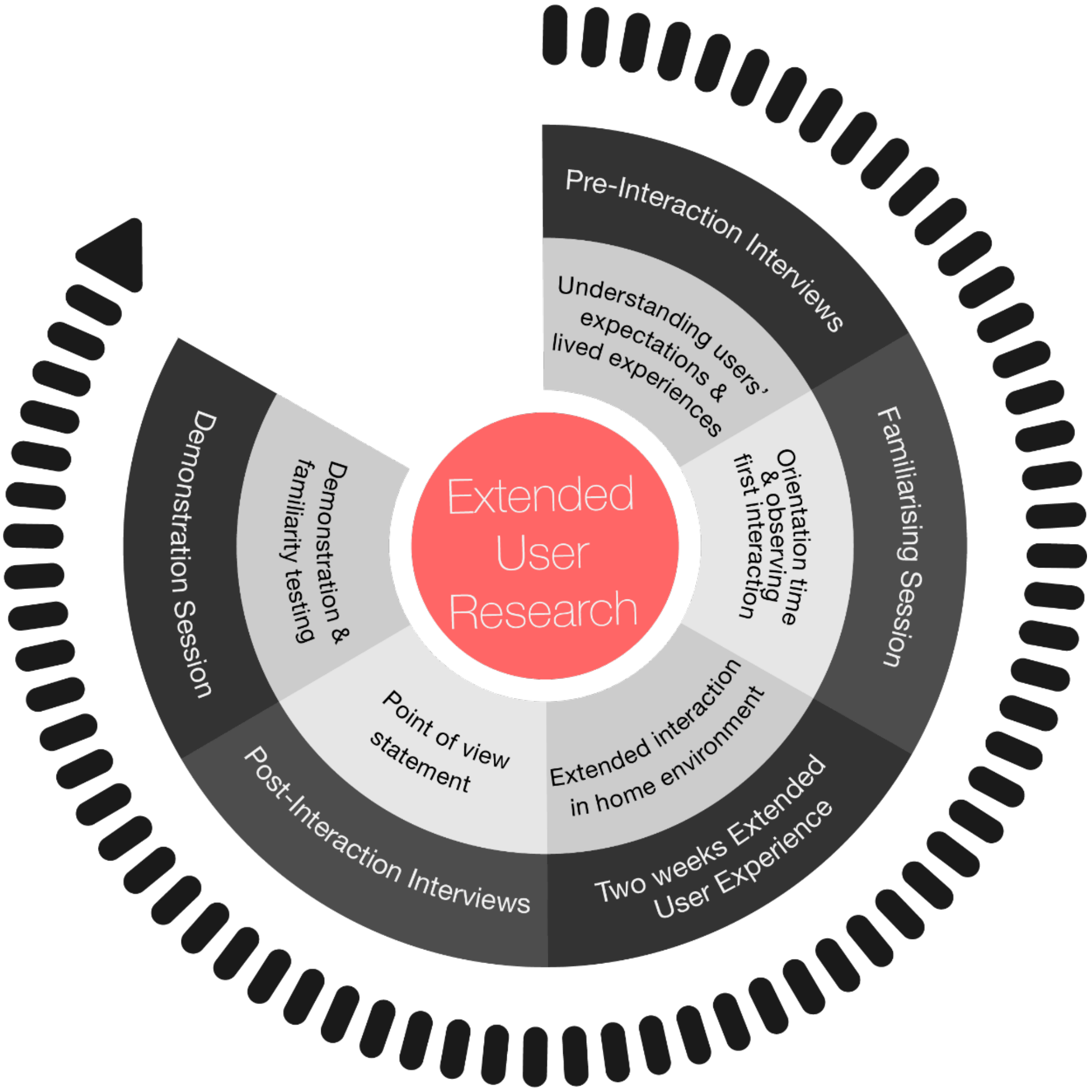

Figure 3.5. Extended user research data collection process

Interviews

I conducted two rounds of semi-structured one-to-one interviews to collect information on users' behaviours and attitudes. Each interview took between 1 to 2 hours.

Pre-interaction interviews

Pre-interaction interviews helped identify the semantic value of smart products and users' perceptions of social robots and their designs before interaction. I investigated participants' reflections on their relationships and experiences with smart products, the probable impact of new technologies such as social robots on their lives and what they expect from these products regarding emotional values. I asked each participant to describe their favourite products and share their lived memories of changes in technology over the years and its influence on their day-to-day activities. I also explored their thoughts on new technologies and what they imagine the interaction with robots to be like. Lastly, I asked them to define what social relationships and companionship mean to them (Appendix E).

Post-interaction interviews

After interacting with Vector for two weeks, more reliable data could be collected about users' points of view. Two-week extended user experience gave enough time for participants to become familiarised and get comfortable with the robot (Karapanos, 2013). Subsequently, the post-interaction interviews with participants were the final data collection stage. In this stage, I focused on identifying any changes in participants' behaviours, attitudes, and physiological responses after the two-week interaction. Post-interaction interviews allowed me to draw comparisons between their first interaction and their prolonged experience by investigating whether an emotional attachment was built toward Vector over time or whether the novelty aspect of it had faded away. It also provided a platform for answering any questions and suggestions participants might have had. I collected the data in a similar way to the pre-interaction interviews and followed up with some optional demographic questions. Demographic questions helped me to better understand participants and allowed enough time for participants to build trust (Appendix F).

Familiarising and demonstration sessions

The second part of my data collection was multimodal familiarising and demonstration sessions I ran at two points after the interviews. I ran these sessions by monitoring participants' attitudes and how they made sense of Vector. I observed their behaviours and what they said about the process. I measured their physiological responses using heart rate variability (HRV) measurements and monitored how Vector engaged with its surroundings. I asked participants to interact with Vector in a vocal-work approach, which allowed them to express their thoughts while interacting with it.

The first-time physical interaction between participants and Vector was captured during the familiarising session. After each pre-interaction interview, I handed out Vector, in its original box, to participants. I shadowed and observed the unboxing process. Participants used the manuals inside the box and followed the instructions for setting up Vector, using its app on their smartphones. I observed the unboxing and installation of the app and users' first face-to-face interaction with Vector. I was ready to provide support and feedback if needed. For instance, one of the participants had some issues connecting Vector to the Internet, and another participant needed support on how to link their Amazon account to Vector to use the Alexa option of it. However, this was the extent of the tasks that were specifically asked of the participants to follow. The app and the user manual guided the participants to explore Vector's offerings. The intention was to allow users to have the freedom of choosing what interactions they would like to have with Vector. This decision allowed for the results to be as close as possible to the user experience of a product in a real context.

I ran the demonstration session after the post-interaction interviews. Participants demonstrated some of the activities and interactions they had with Vector. I observed where they used the robot and how they interacted with it after the two weeks. My aim for the demonstration session was to observe the interaction after the extended user experience to observe and interpret the participants' familiarity, social responses, confidence, and whether there had been a sense of attachment or detachment between the participants and the robot.

I analysed participants' sense of attachment by getting inspiration from the more common definition of user theories, such as the work of Norman (2004), to consider the emotional bond that participants feel toward Vector through a cumulation of positive experiences they had. I also reflected on more recent frameworks established in HRI studies, such as the work of (Rabb et al., 2021), which is heavily influenced by the definition of attachment in social psychology. Participants were asked to reflect on whether they felt a sense of safety, comfort, and support provided by Vector or any other technology. In combination with the participants' reflections, I observed their behavioural responses, whether they were seeking closeness to Vector or showing signs of vulnerability and anxiety brought about by the loss of a robot being taken away. The reflections and observation together could indicate the level of attachment or detachment they have formed toward Vector. Table 3.4 summarises the general procedures and steps followed in both sessions.

Table 3.4. General steps and procedures of the familiarising and demonstration sessions

Familiarising session		
Steps		Procedures
1	HRV measurement via Apple Watch	Capturing users' physiological responses The Apple Watch was given to participants before the interviews so that any changes in their heart rate could be recorded.
2	Audio and video recording of the whole sessions	Monitoring how people feel through what they say, the tone that they speak, and their body language
3	Handing out the Vector's box to participants	Observing the unboxing process and the first-time physical interaction
4	Participants to read Vector's manual to install the app on their smartphones	We provided a Samsung tablet if participants wished not to use their own smartphones. Only 2 participants opted for the tablet.
5	Ready to provide support and feedback for the participants if needed	Supports included providing feedback for installing the app, connecting the robot to the home Wi-Fi
6	Participants followed the app instruction on how to interact with Vector	The app provided guidance such as activating the voice command, playing games, asking questions, taking photos, activating Alexa, and petting Vector.
7	Concluding the first session	Checking if participants feel comfortable interacting with Vector alone before finishing the first session
Demonstration session		
1	Audio and video recording of the sessions	Monitoring and comparing how participants felt in the first and second sessions through what they said, their tone, and their body language
2	Observing participants' interaction with Vector after two weeks	Participants talked about their two weeks of interaction with Vector and shared their views about their likes and dislikes
3	Observing users' behavioural and physiological responses	Observing users' responses to Vector, their personality influence, social context influence and how they described their interactions
4	Observing users' familiarity, sensemaking, and interaction with Vector in comparison to the first-time interaction	They demonstrated some activities and interactions they had with Vector (most participants kept a record of these activities in their journals which is explained in the next section, *Extended user experience.*
5	Observing Participants' final interaction with Vector	The final step was to monitor participants disconnecting Vector and putting it in the box to give back to the researcher. Monitoring this step was significant as it revealed any sense of attachment and detachment built over the two weeks of participants having Vector at their homes.
6	Question and Answer time	Providing the opportunity for participants to ask any questions, raise any concerns and share any interests they would like to communicate with the researcher

Following the study's conceptual framework, my data collection process was based on the UTAUT model (Blut et al., 2022) to understand participants' sensemaking process while observing their physiological responses using MCLM techniques (Chen et al., 2016). The sensemaking process is how people make sense of and understand activities and events surrounding the interaction with a social robot (Papagni & Koeszegi, 2021). I observed participants' sensemaking process, including their curiosity, creativity, and trust in the interaction process with the robot as a new object introduced to them without prior knowledge of it.

I also explored participants' understanding of the available technology in smart products and robots. I captured participants' physiological responses, such as observing their facial expressions and body language, monitoring their heart rate variability (HRV) using a wearable device during the interviews and familiarising and demonstration session[11]. I incorporated multimodal measurements in the sessions to triangulate the data collection process by comparing participants' behavioural responses such as gestures, attitudes, and reasonings with their physiological responses. My perspective and participants' comments about how they felt about their interaction with Vector were also collected.

Extended user experience

In the second stage, I used an extended user research approach to investigate the participants' attitudes and behavioural changes in interacting with Vector over two weeks in their home environments. Participants used journals I gave them to report their daily interactions with Vector, reflect on the amount of time they spent interacting with Vector, describe the experience, and share their feelings.

I designed, printed, and bound the journals at AUT, Art & Design Book Binary Workshop. I designed the journals specifically for the experience (Appendix G). I gave them to participants with Vector after pre-interaction interviews. I invited participants to reflect, share photos, and use drawings or any means of expression to describe their experience, the setting in which they interacted with the robots, and any thoughts and events that occurred during their two-weeks extended user experience.

My focus for using the journaling method was to collect users' stories, thoughts, and emotional experiences that they might have encountered while interacting with the robot. While participants were asked to rate how they felt about Vector, they were encouraged to share their reflections and reasonings for how they perceived their emotions instead of me simply

[11] I used Apple Watch Series 4, 44mm model and Cardiogram app to capture participants' HRV. Further information about the watch: https://www.apple.com/nz/watch/

analysing their ratings. Table 3.5 presents the steps and procedures for collecting the extended user experience data.

Table 3.5. Extended user experience steps and procedures

Extended user experience procedures		
Steps		Procedures
1	Handing out the journals	After the familiarising session, participants were handed a journal to use for reflecting on their extended user experience.
2	Reviewing the example pages and instructions	The first two pages of the journal provided participants with examples of how to fill out each section. Participants and I reviewed the examples together. I provided further verbal instructions before leaving participants with Vector and the journal for the extended user experience.
3	A daily log of interacting with Vector	Journals included 14 days with a daily logging section to record the time and duration of interacting with Vector.
4	Daily rating of feelings toward Vector	After each log, participants were asked to rate how they felt about the interaction by marking the emojis printed on the page only as a guide for them to reflect on their overall experience.
5	Daily reflections	On the right side of each page, participants were asked to reflect on their daily interactions and provide further details of their experiences.
6	Two weeks log of interaction	Participants had Vector for two weeks and continued to report their interactions in the journals daily.
7	Continuous user feedback	The continuous feedback over two weeks allowed participants to reflect on their experiences and the changes in their daily interactions. It allowed them to form a detailed and comprehensive decision about emerging technologies through the use case of Vector.
8	Collecting journals after the demonstration session	Most participants used their journals in the post-interaction interviews to refer back to their various experiences. Therefore, most of the information provided in the journals was discussed in the interviews. After the demonstration session, journals and Vector were collected from the participants.

I initially assumed journals to be a crucial part of the data collection and provide detailed information about the participants' experiences. However, my assumptions about the journaling method changed after the data collection. While most participants invested time in filling the journals, some preferred to reflect on their experience during the post-interactions' interviews. I found that most participants in the post-interaction interviews referred to their journals when reflecting on the experience and shared their journals' information during the interviews.

The beneficial aspects of the journals were that they allowed participants to track their experiences and any changes they noticed over the two weeks. It also acted as a daily reminder for participants to interact with the robot. Participants shared and elaborated on the activities and interactions they had with Vector. They explained if they interacted with it in a different location and social context, such as having other people in their social group involved in the interaction. They expressed how they felt about Vector and the user experience over the two-week.

3.2.5. Data analysis

I combined reflexive thematic analysis with an interpretive user research approach to analyse the data and results. Thematic analysis is one of the most commonly practised forms of data analysis within qualitative research. It is a clustering method that highlights patterned meanings across the dataset. These patterns are identified through a rigorous process of data familiarisation, identifying, coding, interpreting patterns of meaning, and generating themes (Clarke et al., 2015). The reflexive approach of thematic analysis developed by Braun and Clarke (2006) uses a more organic and flexible coding process. In this approach, codes are not fixed and can evolve throughout the analysis. The codes can merge, split, collapse, or even be promoted to themes during the process. Therefore, theme development is the result of clustering similar codes to capture patterns of shared meanings around a central concept.

I used Trint[12], an online audio transcription software, to transcribe the data. The software uses AI to transcribe audio and video automatically. I then reviewed, fixed, and added to the transcripts where the software did not correctly or fully transcribe the conversations. By reviewing the transcripts myself, I spent considerable time on data familiarisation and explored the implicit and explicit meanings of data. Once the transcripts were ready, I started the preliminary coding and note-taking while re-reading the data. During the preliminary coding stage, I coded data without predefined categories. I paid attention to occurring patterns and implemented the coding process by simultaneously reading, listening, and watching the recorded data.

According to Barrett et al. (2019), a person's emotions could not be measured simply by ratings or only through facial expressions. Emotions can have many faces, such as laughing,

[12] Trint is an AI audio transcription software founded by Jeff Kofman in 2014. Further information about the platform: https://trint.com/

crying, smiling, or screaming due to happiness. Similarly, the same expressions, such as screaming, can be used in different emotions such as disgust, frustration or excitement. The human brain predicts emotions through a combination of a person's face, body, and the context of the experience. Therefore, to truly understand and interpret participants' emotions, I needed to watch and listen to participants sharing their reflections on their lived experiences and context and not solely analyse their body or face reactions.

Once familiarised with the data and finished with the preliminary coding, I used NVivo12 (2018) qualitative data analysis software to code data into ready and sensible data for analysis. NVivo allows data to be coded into various categories, cases, and sentiments. These categorisations worked as virtual filing boxes that enabled me as the researcher to visualise gathered information into summarised, organised files. During this phase, I re-analysed the preliminary codes across the whole data set to combine codes and summarise the key patterns and information related to the research. The constructed themes, at this phase, were simply topic summary themes (Braun et al., 2019), meaning they were focused on every point that had been raised in the data and required further analysis. My intention for this process was to access the codes afresh and search for patterns and themes that might have indicated multiple meanings before finalising them.

Collaborating with the supervision team, we reviewed the initial codes and topic summaries for feedback and quality assurance. We started the reviewing process with separate initial coding of the same datasets to ensure and verify that the data interpretations are true to what participants have shared. After reviewing the topic summary themes against the codes and the entire dataset, I modified and reconstructed the themes by focusing on which aspects of data the themes captured and the interesting information they presented. By redefining the themes, I looked for how they formed parts of the entire data and how they fitted together to tell the whole story.

Once the themes were constructed and redefined, the supervision team reviewed them again for final quality assurance and to make sure they were clear and captured the total experience of participants. The final step of data analysis was to write a thick description (Guest et al., 2012) of the results and to decide what themes in which order made a meaningful contribution to present the findings and results of the data accurately.

3.2.6. Participants selection

I organised the data collection process around a "local" context. New Zealand's population, and particularly Auckland's demographic, is international and culturally varied (Schumacher, 2009). However, according to Schumacher's observations, New Zealanders may lower expectations of a service or product and be happy to work through situations. Therefore, a thorough investigation was necessary to ensure I was collecting in-depth information on participants' emotional reflections and expectations.

Participants were selected based on the targeted age category of "active ageing users". My target participants were initially older demographics in the retirement age, the demographic cohort aged 65+ years old who are still independent. The focus was on target users who were not part of bigger communities, such as retired villages, which may have additional social support. However, during the recruitment phase, I found it useful to expand the target group's age to 50+ years old participants. I could explore any variances between the worldviews of participants who were not at the retirement age and those who were retired or close to retirement.

Furthermore, while not all users aged 50+ are close to retirement, the selection of this demographic allowed me to research users that have grown and worked during an era that has gone through the most radical technological changes. I was then able to capture a sociological, emotional mapping of active ageing users' behaviours. The purpose was to reveal consistencies of emotional patterns of ageing users; and inconsistencies of emotional and social patterning as housed within discrete unchanging generational worlds.

I acknowledge that during the provisional year of the present PhD research, I was planning to study both young adult users and older adults to compare their reflections and experiences. However, I noticed that most studies on older adults present a deficit view of ageing and do not research users that are active and engaged in society. I realised that there is a need to fully investigate and understand the lived experiences and needs of active ageing users. Immersing and interpreting the lived experience of both younger and older adults seemed unrealistic for the scope of this research. While I focused on active ageing users' relationship with technology, it would be of interest to contrast it to younger users' experiences in future studies.

I used theoretical sampling and analysis to select the participants (Coyne, 1997). In this approach, the researcher continues sampling and analysing data until a saturation point is reached when no new information is obtained from further data (Draucker et al., 2007). Subsequently, I did not predetermine the sample size. Instead, it depended on when sufficient data were collected to undertake a detailed analysis (Glaser & Strauss, 2017).

Faulkner (2003) shows that a sample size of five may reveal only 55% of the problems and challenges of usability tests. Marshall et al. (2013) recommend a sample of fifteen to thirty is when theoretical saturation occurs. Therefore, I initially considered a total number of twenty participants for in-depth data collection. However, based on the theoretical saturation point of the results, this sample size changed to fifteen participants.

Participants were invited to take part in the research through various platforms, such as digital advertisements on social media, word-of-mouth, and handing out print advertisements and pamphlets to local cafes and shops to give to people. The study was conducted at the participants' homes. Studying participants in their homes enabled me to be immersed in their everyday lived experiences (Martinec, 2004). This approach provided me with the possibility of exploring the environment in which the robot would be set up. It also enabled me to observe participants' behaviour in their familiar context and to interpret the user experience from their perspective (Hunting, 2014).

Fifteen participants took part in the research. Seven of them were aged between 53 to 65, and the other eight participants were 65+. Seven participants were female, and eight participants were male. Table 3.6 illustrates the participants' information in more detail. I have replaced participants' names with pseudonyms to protect their identities. It is worth mentioning that it was easier to recruit the younger participants (aged between 50 to 65) as they seemed more interested in participating in the research. However, once participants gave consent to be part of the study, the second group of participants (aged 65+) spent more time engaging and interacting with the robot over an extended time. In chapter four, I discuss this insight in further detail.

Table 3.6. Participants' information

Name	Gender	Age	Origin	In a relationship[13]	Age category
Paul	M	62	New Zealand	Yes	Between 53 and 65
Valerie	F	56	New Zealand	Yes	
Deepika	F	53	India	Couple	
Udit	M	57	India		
Kathleen	F	55	England	Couple	
David	M	60	England		
Alejandro	M	59	Chile	Yes	
Carla	F	75	New Zealand	No	Over 65
Neil	M	76	Australia	No	
Jane	F	66	New Zealand	No	
Stan	M	66	New Zealand	Couple	
Maria	F	66	New Zealand		
Donna	F	71	New Zealand	No	
Frank	M	67	New Zealand	Yes	
Richard	M	81	England	Yes	

3.2.7. Ethical considerations

I considered the ethical impacts on participants at all stages of the study. To ensure the research's procedure complied with the ethical principles, I submitted an ethics application to AUTEC. The committee approved and updated the application on the 15th of October 2019 (Appendix B).

The Ethics application included information about the research objectives, the reasoning for conducting this study, the procedures and stages of data collection, and the participants' Information and Consent forms. The ethical considerations included:

1) Maintaining participants' confidentiality and my obligation to not share any identifiable information or captured data without participants' informed consent and

[13] Deepika and Udit were interviewed together for both interview sessions. Kathleen and David were interviewed separately. Stan and Maria were interviewed together in the post-interaction interview only.

permission. It included using pseudonyms to protect the real identity of the participants and ensure confidentiality.

2) Informing participants that their participation in the research is voluntary.

3) Giving the participants the right to withdraw from the research at any point before the findings have been produced.

4) Make sure the participants are fully aware that the videos and photographs will be used for transcription and analysis of the data. However, these materials may only be used in the thesis if participants' identities are protected and not recognisable. In any situation, participants' content approval must be obtained first.

All the above information was integrated into the Participants Information Sheet (Appendix C) and Consent Form (Appendix D).

After participants voluntarily contacted me and expressed their willingness to participate in the research, they were asked to share their contact information and email in order to receive the information sheet and the consent form before participating in the study. At the beginning of the first interview session, I presented the participants with hard copies of these forms. I asked them to read and review the forms again, and if they agreed with the information, sign the consent form. All volunteered participants have signed the consent form to participate in this research.

Trustworthiness of the research

Carlson (2010, p. 1103) defines the trustworthiness of the research as the amount of trust given to a researcher that they have covered all the potential considerations to ensure data is ethically and properly collected, analysed, and presented. To give assurance about the quality of the research methods and findings of the study, I followed Treharne and Riggs's (2014) facets of transparency, personal reflexivity, transferability, and triangulation for data collection and results.

Transparency

Transparency is the clarity and reliability of all sections of the research report. Transparency can be achieved by matching the rationale, research question, philosophical stance, methods, and findings (Treharne & Riggs, 2014). The work of APSA's Ad Hoc Committee on Data Access and Research Transparency (DA-RT) suggests three specific requirements for research transparency: data access (Elman & Kapiszewski, 2014), analytic procedures, and references for all pre-existing datasets used (Lupia & Elman, 2014). The DA-RT initiative, first launched in 2010, resulted in the revision of the Ethics Guide (2012) by American Political Science Association (APSA). They identify three principal forms of transparency in their Ethics Guide: data access, production transparency, and analytic transparency.

Following the Ethics Guide on transparency, during this research, I made sure to clearly explain the conceptual framework in which the research was designed. The research approach design and the adaptation of methods were rationalised, cited and clarified as to how they fit the aim of the study. I presented the literature that shaped this study and my worldview while understanding this is not the only approach to address the objective of this research. I acknowledge my own subjective lens and background's influence on the study. I aimed to clearly exhibit my interpretations with direct quotes from participants, observation notes and other data to clarify how my interpretations of the context were shaped and how they link or diverge from the literature.

Personal reflexivity

In an interpretivist paradigm, research is co-created between the participants and the researcher (Reeves & Hedberg, 2003, p. 32). Therefore, reflexivity is an important part of the research process as it encourages the researchers to question their assumptions about the study's nature and structure. It also helps the researcher to be aware of their influence in the research and how their own experiences, identity, and worldview may affect the research outcomes (Finlay, 2002; Jacobson & Mustafa, 2019).

Throughout the present research, I engaged in personal reflexivity by keeping a journal to record my reflections, thoughts, interactions, and observations. Most of the reflections are related to my understanding of the literature and, more specifically, to my field notes. My goal was to ensure my assumptions and biases of the active ageing users were captured separately during the observations and interactions, mainly as I am part of a different generation (millennial). While these reflections formed the basis of detailed narratives of this thesis, the following are some key notes on the impact this research had on my perspective as a researcher.

The foundation of this work started with my master's thesis: *The Use of Emotional Design for the Malaysian Automotive Industry* (Moradi, 2015). My position as a designer up until this present research was a traditional design perspective focused on aesthetics and sensorial exploration of design elements on users. My master's thesis found that for an effective analysis of user-product emotional interaction, two significant parts, *impression* and *representation,* need to be considered. The impression stage consisted of understanding users' impressions and emotions toward products aesthetics, such as excitement, joy, and boredom, based on an emotional measuring tool designed by Desmet (2005). The representation stage was conducted to understand the characteristics of products' visual representations, such as masculine, cheerful, and bold, based on the Kansei Engineering method of measuring emotions (Nagamachi, 2010).

My master's study focused on exploring design elements within the automotive design market in relation to how significantly they affected users emotionally at the pre-possession stage. I researched how aesthetics and styling in car design play an essential part in the user's emotions and purchasing decisions, similar to studies conducted by Warell et al. (2006) and Karjalainen (2007). During the provisional year of this PhD research, when reviewing different literature, I found that while it is necessary for designers to create aesthetically appealing products, research indicates the competitive advantage of a product cannot be based on just the aesthetics (Homburg et al., 2015; Jo et al., 2017).

Placing a successful technology on the market is the most challenging procedure, and companies cannot compete on product styling alone. Therefore, building on emotional design theories, I began to shift my focus to consider the influence of different factors in robotics and automation technologies on users' lives and to understand users' worldviews, behaviours, and needs. My expectations of the outcomes of this research changed to wanting to assist designers in delivering meaningful experiences in the era of digital technologies.

As mentioned in earlier chapters, my research focused on the user experience of active ageing demographics to propose a more inclusive approach. Similar to common approaches in usability studies on older users, I began exploring this research with a preconceived, stereotypical understanding of the ageing population. I acknowledged I was biased, assuming the majority of the ageing population might not be into technology or want to use technological devices and robotics as assistive devices only. Reflecting on the data collection phase of my study, I had the opportunity to meet inspiring people who were fascinated and curious about the opportunities that come with technological advancements. It has been an informative and profound experience for me to have the privilege of participants sharing their worldview and contributing to the study.

Transferability

Transferability – also called external validity or analytical generalisation – questions how useful the study is for informing the field of research and whether the findings are transferable to people from other community members (Polit & Beck, 2010). It is recommended for researchers to provide a clear description of the research context. They need to clarify where and how the sample was obtained and explain who the participants are, enabling the readers to compare the study with their situations (Merriam & Tisdell, 2016, p. 253).

Throughout the research, I presented full descriptions of participants, research findings, discussions of specific generations, and how decisions were made during the study with adequate evidence. Since data stemmed from active ageing participants aged between 53 and 81, the methods and steps I took in this study may be transferred to other field research studies in the HCI and HRI but not generalised. Generalisation was not my goal for this research. Therefore, the study not being generalisable was not considered a constraint, nor does it limit the quality of the study.

Triangulation

A question remains as to whether my interpretation as the researcher captures and extracts participants' perception of interacting with social robots and their experience of living in a digital era. In order to ensure the reliability of the designed framework, I have adapted the practice of triangulation by combining different data sources to better understand the complex nature of user-robot interaction (Wrigley et al., 2010). Triangulation is a concrete approach for ensuring the quality of research by applying multiple lenses to data in order to develop the research findings (Denzin, 2012).

Triangulation has been alternatively introduced under the term crystallisation in qualitative methodologists (Richardson, 2003). The crystallisation approach argues that the triangle is a rigid and two-dimensional object, while the crystal presents multidimensionality with an infinite variety of shapes and angles to research (Ellingson, 2009). Both traditional and postmodernist worldviews argue that a multimodal approach to researching a topic can provide the researcher with a deepened, detailed understanding of it.

I argue that observing a snapshot of participants' interactions can merely represent one's constructed reality and the influence of the social context. Therefore, extended interviews were combined with observations and the familiarising and demonstration sessions before and after the extended user experience to understand participants' worldviews more comprehensively. First-time interactions were reinforced by supplementary monitoring of participants' heart rates to include quantifiable findings that could support my observations. During the two-week extended user experience, I asked participants to record their experiences in the journals to understand better how their experiences and feelings may have changed over time. By applying a multimodal user research approach, I managed to evaluate the study from different viewpoints. It made the research less biased compared to episodic experiences studied in controlled environments.

3.3.Summary

In this chapter, I outlined that the user relationship with technology is a multidimensional process. The users' perceptions and their relationship with technology are shaped by overlaying layers of users' reflections, reasonings and lived experiences, which requires extended user research to understand and interpret them. This approach helps determine the causes, changes, and other factors influencing a user's perspective of an experience. Some factors include users' emotional experiences, social aspects, the context of use, and product affordances and usability.

I conducted my research over two weeks, enabling the participants to have an extended user experience. It allowed them to judge the experience of interacting with a social robot from first-time interaction to extended use, which is less biased compared to episodic experiences in controlled environments. The conceptual framework for this research was shaped by theories from user research theories in design, UTAUT and MCLM frameworks. Multimodal data collection methods were used to validate and minimise biases around researching users' emotional experiences and reflection on the human-technology relationship. It enabled the study to instantiate comprehensive information, ensuring the reliability of the designed framework and research outcomes.

CHAPTER 4. RESEARCH FINDINGS

"Hidden in the physical workspace, in the user's words, and in the tools they use are the beautiful gems of knowledge that can create revolutionary, breakthrough products or simply fix existing, broken products. People do strange things – unexpected things – and being there to witness and record these minute and quick moments of humanity is simply invaluable."

- Jon Kolko *(Thoughts on Interaction Design,* 2010*)*

4.1. Theme 1: Perceptions of technology

Fascination with a sense of wary

Immersed versus intimidated

4.2. Theme 2: Coevolution of human and technology

Assistive aid

Information source

Creativity and productivity

Independence versus isolation

Quantity and quality of communication

4.3. Theme 3: Interactivity

Learnability

Familiarity

Responsivity

Playfulness

Tangibility

Novelty

4.4. Theme 4: Privacy

Positive bias

Lack of agency

The humans behind the technology

4.5. Theme 5: Companionship

Feeling forgotten

Realness and having a soul

4.6. Summary

This chapter presents the generated themes from the collected data to contextualise the study's findings and insights addressing active ageing users' experience of interacting with smart products. I examine the insights in relation to the literature using the paradigm and framework introduced in Chapter 3. I used a multimodal user research approach to capture aspects which contribute to the active ageing users' experience of interacting with emerging technologies. By using this approach, I immersed myself in the experience of the participants. I strived to better understand participants' emotional and physiological responses toward technology and smart products. I sought to carefully explore the context of the interaction and the social actors involved in the process. However, the findings reflect on all data collection stages, as they were interlinked and connected, with each stage supporting and providing insights linked to the other stages.

I provide my interpretations of the data collected from participants' feelings and thoughts on their past experiences with technology and the two-weeks interaction with Vector (the supplied robot for my study). As presented in Chapter 2, the user experience can be studied from multiple perspectives. Current studies of how the older population interacts with emerging technologies have not sufficiently or adequately addressed the users' emotional experience through an extended multimodal user research approach.

I organised the chapter into five main sections, which cover the themes that were generated from my process of analysing and interpreting the data. In Theme 1, findings were largely constructed from the pre-interaction interviews conducted in stage one of my data collections. The purpose of this stage was to understand participants' beliefs and perceptions of technology and smart products as one of the primary inquiries of this thesis. I ran this inquiry by exploring the effect of rapid changes in technology on ageing populations' lives and highlighting the influence of social and generational differences. Theme 2 presents my understanding of participants' reflections on how technology intersects with their everyday activities and its impacts. Participants' aspirations and challenges of living in a digital era are discussed as well as their purpose for accepting and using emerging technologies. In Theme 3, I present participants' outlooks on affective interaction and their experience with smart products. In Theme 4, I discuss the contextual factors influencing participants' views on privacy, information sharing, and lack of agency for users presented through autonomous technology. Lastly, in Theme 5, I interpret participants' hedonic motivations, sentiments, values, and worldviews concerning companion technologies. Table 4.1 presents a summary of these five themes and their relationship to my study's conceptual framework.

Table 4.1. Summary of the themes and outline of Chapter 4

No.	Themes	Subthemes	Links to the conceptual framework[14] in relation to key factors considered in the literature[15]
1	Perceptions of technology	- Fascination with a sense of wary - Immersed vs intimidated	- Performance expectancy - Subjective, behavioural, and reflective responses - Memories and past experiences - Product semantics and affordances
2	Coevolution of human and technology	- Assistive aid vs self-discipline - Information source - Creativity and productivity - Independence vs isolation - Quantity and quality of communication	- Socio-cultural context - Facilitating conditions - Habit - Memories and past experiences - Subjective and reflective responses
3	Interactivity	- Learnability - Familiarity - Responsivity - Playfulness - Tangibility - Novelty	- Effort expectancy - Hedonic motivations - Facilitating conditions - Individual characteristics - Task performance - Use environment - Product attributes - User familiarity
4	Privacy	- Positive bias - Lack of agency - The humans behind the technology	- Context influence includes the use environment, socio-cultural context, and facilitating conditions - Social influence - Reflective responses - Memories and past experiences
5	Companionship	- Feeling forgotten - Realness and having a soul	- Hedonic motivations - Social influence - Individual characteristics - Product attributes

4.1. Theme 1: Perceptions of technology

I deemed it essential to start my inquiry by unpacking what technology meant to participants and discussing the term from their personal views. Participants reflected on the meaning of the word "technology" and shared their emotions and feelings toward it. My interpretations delve into the notion of smart products as emerging technologies from participants' views and explore how they conveyed their feelings about technological changes.

---

[14] Introduced in Section 3.2.2. Conceptual Framework.

[15] Introduced in Section 2.6. Key factors to consider.

At the beginning of the pre-interaction interviews, I asked participants to share their perspectives on what technology meant to them. Most participants found defining "technology" a complicated and challenging task as they associated technology with many products through the years, from simple mechanical artefacts to very complex AI systems available in the market. Neil's definition of technology exemplified the vast array of artefacts and information participants associated positively with technology:

> *When I think of technology, I think of, first of all, the Internet, which is all developed in my lifetime. I think of the technology that makes everything available, from the motor vehicles we drive to the supreme, sending up satellites and everything in between, everything that enables modern society to function effectively.*
> – Neil (male, 76 years old, pre-interaction interview)

The meanings most participants associated with technology and the changes it presents to their lives were predominantly linked to the use of digital technologies such as smartphones and the accessibility and simplicity which comes with having everything in one place. Similarly, other participants associated technology with the Internet and various forms of computing systems embedded into different devices that made everyday tasks simpler and more effective. However, almost all participants expressed that such apparent simplicity has not necessarily made their life easier. Participants shared that for them, there is a huge amount of learning involved with keeping up with the changes and using different technologies to reach simple solutions.

Therefore, I shifted my focus to explore the impact of such technological changes on participants' experiences. I drew inspiration from research on the fast-paced changes in technology and its influence on the user experience, such as Hassenzahl and Carroll (2010); Tettegah and Noble (2016); Hassenzahl (2018); Lambert et al. (2020). Based on the approaches used in these studies to design for emotions, I explored how technological changes in participants' surroundings may affect them emotionally. By examining the overarching emotional experience of the participants toward technological changes, I aimed to bring awareness to the circumstances surrounding individuals' lived experiences over the years while considering their individual beliefs and worldviews regarding interacting with emerging technologies. I asked participants to reflect on their embodied experience of technological changes. By expanding on such experiences, participants expressed reasons for accepting emerging technologies into their lives.

4.1.1. Fascination with a sense of wary

With the participants' acknowledgement of encountering many rapid technological changes over the years, I considered their emotions to play a significant role in their social and personal activities facilitated through and with technology. They reflected and compared their lives before and after technological changes, from the first generation of personal computers to smartphones. I interpreted participants' emotions to a wide variation of feelings. Their emotions consisted of excitement, a sense of curiosity and discovery, and infuriation and frustration of trying to catch up and learn all the technological changes which come with emerging products. As presented in Figure 4.1, participants' emotions can be interpreted as a paradoxical combination of fascination and a sense of wariness.

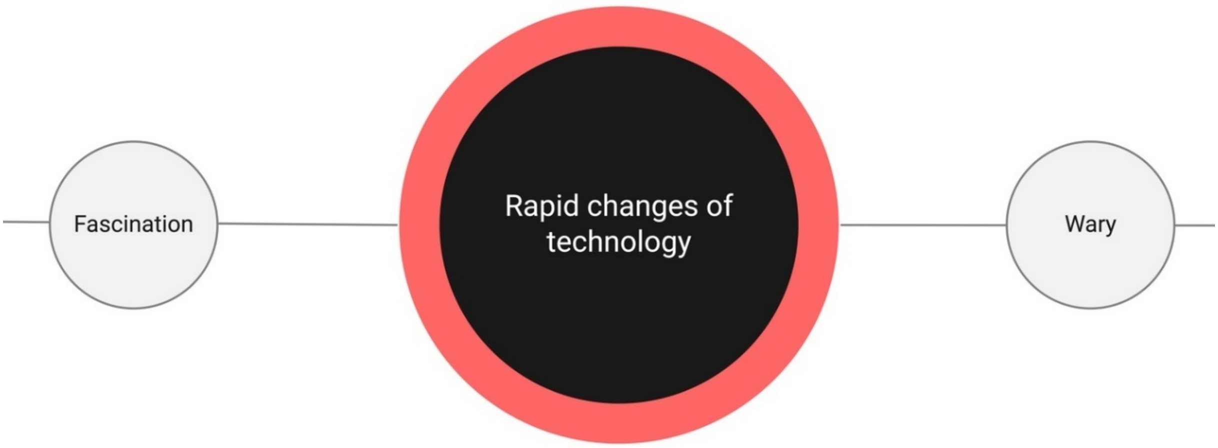

Figure 4.1. Users' emotions about rapid changes in technology

The fast-paced technological changes which required participants to adapt continuously were manifested in some participants' feelings of submission. They believed they had no other choice and subsequently chose to see their experiences as positive; otherwise, the constant adaptation to changes could be overwhelming. Carla expressed her feelings about technology in our pre-interaction interview as follows:

> *It's definitely a positive because, for me personally, it has to be, because if you are not positive about it, you go, huh? [pause] It's moving so fast. But somehow, you need to keep up with it as best you can because everything's going online. So positive, definitely must be positive about it.*
> – Carla (female, 75 years old, pre-interaction interview)

Carla's emotions and use of words when expressing her emotions indicated a sense of self-motivation. She suggested her feelings "have to be" positive. Her pause right after the interjection of "huh?" and her frustration that technology is "moving so fast" indicated her doubts and concerns. She argued that emotionally she "must be" positive about technology, indicating she has no other choice but to feel positive.

User perceptions and attitudes toward technology can influence their experience and adaptation (Scherer et al., 2018). Overall, participants' attitudes toward technology were optimistic. Most participants viewed the role of technology in their lives as positive. They reflected on the accessibility and possibilities technology has made available to humans over the years. All participants were fascinated with the inventions that have made the world available at their fingertips.

However, almost every participant felt wary about some negative encounters introduced by technology. Most participants based their concerns on their past experiences or the potential dangers of technology narrated by different popular media. The participants' fears due to past experiences were mostly around their adaptation to changes. They had difficulty adapting to various digital services since each came with different interfaces. Some participants were also overwhelmed with keeping up with the continuous advancement of technology.

The work of Hook et al. (2018) highlights the importance of supporting users in dealing with change. They investigated the educators' experience of adapting to new modes of teaching. Their results suggested that many users may have had a set manner and working style throughout their entire careers. As such, they can become anxious about change and reticent to embrace it. Therefore, to promote successful change behaviour in their study, acknowledging and being sensitive to the users' anxiety to build trust, confidence and resilience was a central practice.

Similarly, most participants expressed that constant adaptation to new technology can be exhausting and complicated. It became immediately apparent that one of the central parts of my study was making sure to acknowledge users' challenges and fears of adapting to emerging technologies. Hence, the importance of empathic research for understanding active ageing users' needs became even more prominent.

Jane shared her sense of infuriation toward technology immediately at the beginning of the pre-interaction interview. She then reflected that it is easy for her children to work with multiple technologies and apps. With just a few taps, they could manage to figure out a problem Jane might be facing. However, for her, the interaction with technology is ever-changing, unnatural, and fraught with errors:

> *Technology? Oh, it infuriates me! [laughter] It does! It really does! I mean, it doesn't come naturally to me at all.*
> *Each app is different; each looks different when you download it. So, it's just a lot of trial and error.*
> – Jane (female, 66 years old, pre-interaction interview)

Nonetheless, after expressing her frustration with technology, Jane talked about the positive aspects of smartphones. She gave examples of how smartphones have made "amazing" changes in her daily activities. Jane's examples included searching the Internet for information instead of using encyclopaedias, online banking, e-tickets, and self-checking that she can do through her smartphone.

Valerie also felt optimistic about technology. She expressed her willingness to know more about it but was also a bit scared. For instance, Valerie viewed the implementation of AI in daily experiences with trepidation, saying, "How do I feel about an AI in our everyday lives? Again, excited but wary!". Valerie acknowledged that science fiction movies or negative rumours had influenced some of her concerns. However, such alarming undertones made her realise that sometimes good intentions turn into unintended results:

> *On the one hand, I think it's amazing, and it's really interesting. . . . and on the other hand, I think it's a little bit scary. But I think a lot of that is scaremongering like there's a lot of stuff about AI taking over everybody's jobs . . . , and the reality is that's not really the way it's going to work. I mean, we are also great fans of*

> *things like Black Mirror [laughs]. Like things that seem like a really good idea can sometimes not be such a good idea after all.*
>
> – Valerie (female, 56 years old, pre-interaction interview)

Valerie's responses indicated the influence of media on people's perceptions of technology. Interestingly, several other participants referenced science fiction movies and books as examples of potential directions for human-technology interaction in future. Science fiction movies and novels have shaped some negative emotions toward technology. Without being asked about fictional narratives, roughly one-third of participants referred to them when sharing their concerns about technological advancements. The media's pessimistic depictions of the dark side of technology have influenced participants to be more mindful and cautious of human-technology interaction. The results indicated that the influence of societal and cultural construction on technology's perception could be crucial.

One example of societal construction that could be compared with participants' reflections on the influence of media is the historical mass hysteria on the Y2K or the Millennium Bug caused by the formatting of the calendar-based data for dates beginning in the year 2000 (MacGregor, 2003). It was one of the great global media events for years, leading up to the change of the millennium with different media taking different positioning toward the complexity of the issue and some disregarding it. Y2K generated fear that a doomsday scenario would happen due to the flawed technology design (Burton & Lain, 2020). However, the event did not happen as people were prepared for it and worked behind the scenes to implement the fixes (Lamble, 2011).

Similarly, the participants' reflections indicated that popular culture shapes views on how technology is perceived. Such cultures can construct concerned views on the liability of technology and its designs. Y2K and its portrayal in the media illustrate the type of fear my participants expressed was partly due to the media presenting rather complex technological themes in simplistic terms.

4.1.2. Immersed versus intimidated

I noticed in the data that participants characterise generational differences in the uses of technology. When discussing different aspects of technology, the younger participants found themselves in-between generations. They felt separated from the other generations as they perceived the young generation as too immersed in technology. It seemed to them that for the younger generation, it is hard to see life outside and without technology. Some participants also suggested that seniors, the generation before them, seem intimidated by technology. However, many participants located themselves in the middle ground, somewhere in the spectrum between the two extremes. While most participants valued technology and its purposes, they also held a critical view of technology. All participants mentioned they are not fully immersed or entirely overwhelmed by technology; instead, they seek a reason for using a new technology. Following is an example of Deepika sharing how she felt when talking about technology with other people:

> *It depends on whom I am having the discussion with. Generally, with the younger people that they are so driven by technology, it's almost like they've lost a childhood that we had or physical experiences. But at the same time, when you talk to older, like really old people, they are totally phased out by it, and they get almost repulsed by it. They don't want any more of it . . .. So, they get a bit daunted by it. And when you talk about technology to people from our generation, they kind of go; this is just amazing, isn't it? Like, imagine in future, this is what's going to happen, and they're going to be like saying, oh God. So, we're right in the middle of it. So, it's quite an interesting experience.*
>
> – Deepika (female, 53 years old, pre-interaction interview)

Based on similar responses from other participants, it seems many saw themselves as a generation with self-awareness, reflection, and reasoning on how much technology they need. They argued they try and want to catch up with technology and do not want to feel left behind. However, they critically reflected and acknowledged the importance of self-discipline and being in control. They knew how much technology was considered enough and when to adapt and learn to work with it. They seem to appreciate the importance of seeking value before bringing new technology into their lives. In Figure 4.2, I present a brief visual description of how participants view their relationship with technology as "engaged" compared to generations before who are "immersed" and those after them who are "intimidated".

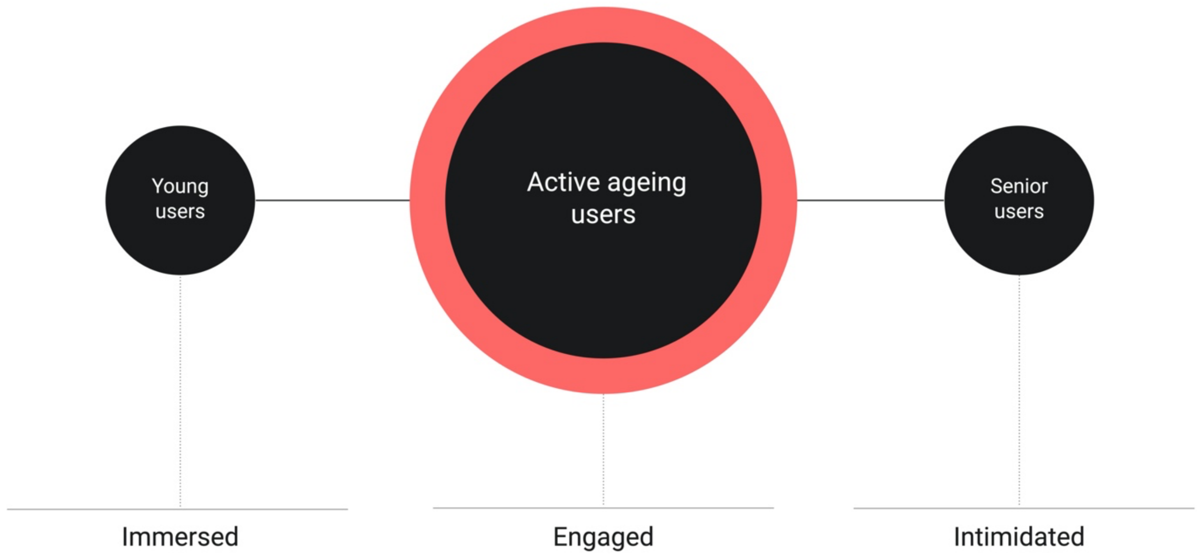

Figure 4.2. Active ageing users' views of themselves in comparison to other generations

Most participants also reflected that digitalised societies nowadays expect too much from people to learn and understand. They empathised with the younger generation of users, who are expected to learn complex skills and tasks even before reaching school age. They felt that being exposed to too much technology makes the younger generation overly reliant and immersed in technology. One of the participants, Maria, shared her concerns about the influence of technology on primary and early childhood education:

> *One thing that worries me about education is that the basics may be forgotten because of the excitement of technology . . . Because kids do robotics stuff at school now. But can they read? Can they write!? Can they hold a conversation? I think it's so much more important in education. It's got to be on a balance! These kids need to be out . . . To me, the first five years are the only time in your life you can play and surely play is so much more important because play is learning everything about the world. And you get stuck in a classroom. A lot of kids don't have the hand-eye coordination to write or the attention span to read.*
>
> – Maria (female, 66 years old, pre-interaction interview)

David and Kathleen similarly worried about emerging technologies interfering with younger generations' interpersonal skill-building. Similar ideas appeared throughout the data collection that the society and workforce expect people to know everything and keep up with all the changes. Most participants thought multitasking is now considered a norm compared to before when single-tasking and expertise in one field were practised and appreciated. The patterns suggested that technology has not made life simple. Instead, technological changes that occur much more rapidly have pushed the pace of living and working faster and more complicated for all generations.

Most participants said they empathise with the other generations' perceptions of technology. They expressed concerns for the younger generations who rely on technology for many of their daily activities and the impact it might have on their lives. Participants were also aware of the social and emotional effects of technology on seniors and the generation before them. Since they are still an active generation who are independent, and some of them are still working, they understand the challenges that come with adapting to emerging technologies. Similarly, as they are either retired or close to retirement age, they seem to recognise the overwhelming feeling of interacting with various technologies, which could bring a sense of social isolation to the ageing population.

4.2. Theme 2: Coevolution of humans and technology

Some participants explained the notion of technology as an endless evolution that will always be part of the human experience. Their responses suggest that humans and technology are integrated. If one changes, the other changes as well. This idea leads to the concept of mutual dependency and coevolution (Ihde, 2006). The term coevolution in the field of STS refers to the hybridisation between humans and technology as an interactive system and the ability of their social relationship to modify its behaviours effectively to the changing circumstances based on acquired information from the surroundings (Döppner et al., 2019; Dengel et al., 2021).

For most participants, adaptation was a shared attribute of technology and humans. Therefore, I decided to refer to the above using the term coevolution, commonly used in STS studies to describe the evolution of humans and technology (Terveen, 1995; Libin & Libin, 2005; Damiano & Dumouchel, 2018). The term coevolution does not view humans and technology as independent variables (Mackay, 2000). Instead, it emphasises the active evolvement of both humans and technology in a situated interaction with emergent outcomes. Udit's definition of technology points towards this continuous coevolution of humans and technology:

A teacup! If it's designed in a particular way, that is better than it was last year or the teacup of a hundred years ago. It's technological. So, for me, technology is always there. [Pauses] I think we are part of technology. And we're enveloped in it, and . . . our lives move with it endlessly.
– Udit (male, 57 years old, pre-interaction interview)

Udit suggested that technology is part of human lives and experiences. It continuously evolves and changes with humans, and we as humans move and change with technology. Like Udit's, all participants seemed aware that technology is forming various new systems and meanings in the world. Such formations include new types of relationships, social prescriptions, different ways of living, work, communication, entertainment, and other daily activities such as reading books and listening to music.

On the other hand, some participants then expanded that technology does not necessarily dictate how people respond or behave. Instead, it is the human conscience which decides how to use technology. For example, Alejandro argued that it is humans who determine the purpose and use of technology:

Nuclear energy can be used for good or can be used for bad. Technology tends to reduce jobs for people. The expectation of the people is very aggressive. Technology tends to be isolating! But it's not the technology. It's the people dealing with the technology . . .. You use it good, or you use it bad. It's your conscience that decides.
– Alejandro (male, 59 years old, pre-interaction interview)

Overall, participants' views on technology reflected the social construction of technology, which argues that user behaviour and technology shape each other (Lockton et al., 2010). New artefacts dictate new behaviours in users. Users operating an artefact, different to designers' intent, shape the interaction and the artefact's meanings. Design theory refers to this as expected and unexpected outcomes of designs that are both positive and negative (Gültekin, 2004; Olimat, 2013; Monteiro, 2019).

As expressed by most participants, when new technological events occur, their natural tendency is to adapt to them. The impact of these events on participants' lives, activities, and sociocultural aspects of their lives would assess their adaptation somewhere between a spectrum of positive and negative experiences. Technological developments could form an activity or a situation into a simpler but not necessarily easier one (Cowan, 1983). For example, one of the participants, Donna, shared that having an e-book reader has enabled her to store all her books in one place and have access to them all the time. On the other hand, Maria, another participant, provided the example of feeling overwhelmed by the raised social expectation to immediately respond to emails and instant messages when having a smartphone.

While most participants analysed the outcomes of technology as positive or negative experiences, for them, technology itself was not a split between good and bad. They were not so critical of technology itself but of the output of the interaction between humans and technology. However, not being critical did not mean participants were automatically uncritical. Similarly, taking a critical stance need to be scrutinised to understand what criticality implies. In science and technology studies (STS), there has been a long debate about the perceived uncritical acceptance of technology and users' reflection on it.

Sayadmansour and Nassaji (2013) regard users as the "uncritical mass" who merely utilise technologies to meet their everyday needs. Their study suggested that users do not assess new technologies' quality, ease of use, and cost-effectiveness. They argue that users expect experts to do the research and be ethically responsible by making the public aware of any technology's potential harm. While this view is somewhat aligned with participants' acceptance of technology for what it is, it provides a narrow view of the matter.

There is no easy way to be critical of the technology as it is complex and operates as a 'black box' (Latour, 1999). Latour argues that when technology is working efficiently, the focus can only be on its input and output and not the internal complexity of the system. A Blackbox cannot be opened and, therefore, cannot be understood. The design of the surfaces hides the complex negotiations between the user and the interface (Heilig et al., 2011). That is to say that the participants were critical of what they could see and experience within the human-technology interaction and could judge the output of these interactions.

Nardi et al. (1999) suggest the conversations about technology are usually positioned at the extremes of uncritical acceptance and condemnation, with both views accepting technological change as inevitable. Such positionings miss exploring the important aspects of technological change, which is evolving social meaning and integrating into social life. It is not enough to speculate about technological changes only regarding functions and performance.

Matthews (2019) argues that the challenge is to introduce a critical view into the evaluation of technology use and the kinds of technologies which could be available in the future. This view on critical thinking was aligned with some participants' thoughts and concerns around the outcome of user interaction with technology.

A typical direction technology takes over time in terms of value, expectations, and visibility is called the 'hype cycle model'. This model has been developed by Gartner Inc. to trace the evolution of technological innovations and to improve the assessment and forecasting of technologies during their initial development period (Fenn & Raskino, 2008). The model suggests that technologies progress through consecutive phases marked by a peak, disappointment, and an unturn of hopes. It depicts a graphical and theoretical presentation of emerging technologies' development, acceptance, and social application (Dedehayir & Steinert, 2016). For example, when I asked Udit and Deepika to share whether their interactions with different technological devices have changed over the years, they answered that it is the conjunction of users' knowledge of technology and technology awareness of users that produces a familiar interaction between the two:

> *". . . we are getting more familiar with it. And I think the designers of the program are getting more familiar with the users. And therefore, it's a conjunction of both that is actually making the product more user friendly."*
> – Udit (male, 57 years old, pre-interaction interview)

> *". . . technology becomes more and more accessible, and it becomes a part of you, and you become familiar with it and that it becomes familiar with you as well, you know!"* – Deepika (female, 53 years old, pre-interaction interview)

In my view, participants interact with and view technology as an ever-changing shared experience, which is taking place between users and emerging technology. Most participants' views can come across as technological deterministic. Yet, humans also affect the use of technology and its changes. As Alejandro mentioned before: "technology is not good or bad". Such views do not necessarily mean the technology is "neutral" (Vermaas et al., 2011). Humans and non-human agents are not separate but intertwined. I acknowledge that some other scholars might view participants' way of explaining their interaction with technology in the interviews as simply technological determinism that technology is the source of change and humans adapt to it. It is not a limitation but one interpretation amongst many others in the scholarly field.

I link participants' reasonings on the changes technology imposes on humans to Latour's concept of technical mediations (Latour, 1994). He suggests that when a technology is introduced, humans adjust or readjust their skillsets around it. However, "technical mediation" refers to both the intentions of humans and the functions of non-humans (emerging technologies). It does not necessarily invoke a clear distinction between humans and nonhumans in which the terms are applied (Verbeek, 2006).

What Latour achieves is to avoid both technological determinism over human (materialism) and human determinism over the technical (anthropocentrism). To put it in other words, technical mediation for Latour refers to a co-influence between human and artefact (Latour, 1992). Thus, he presents an alternative to the problem of technology dominating humans or humans governing technology. The technical mediation concept considers humans and technology as a symmetrical pair. The human-technology merger will then bring forward a new emergence of new properties.

To explore participants' reflections on the outcome of the human-technology coevolution, one of the critical factors was to expand on their emotions, views, and reasonings on the interaction. Most participants categorised technology as a tool. They explained that the efficiency of technology had brought convenience into their lives. They also reflected how their user experiences had been influenced by technology over the years, both positively and negatively. I categorised participants' views on using technology into five areas that had positive and negative impacts on their lives. These five areas included technology designed for assistive aid, information source, creativity and productivity, independency, and communication, as presented in the middle part of Figure 4.3. All participants suggested that using technology is often a trade-off, located somewhere in the spectrum of positive and negative experiences.

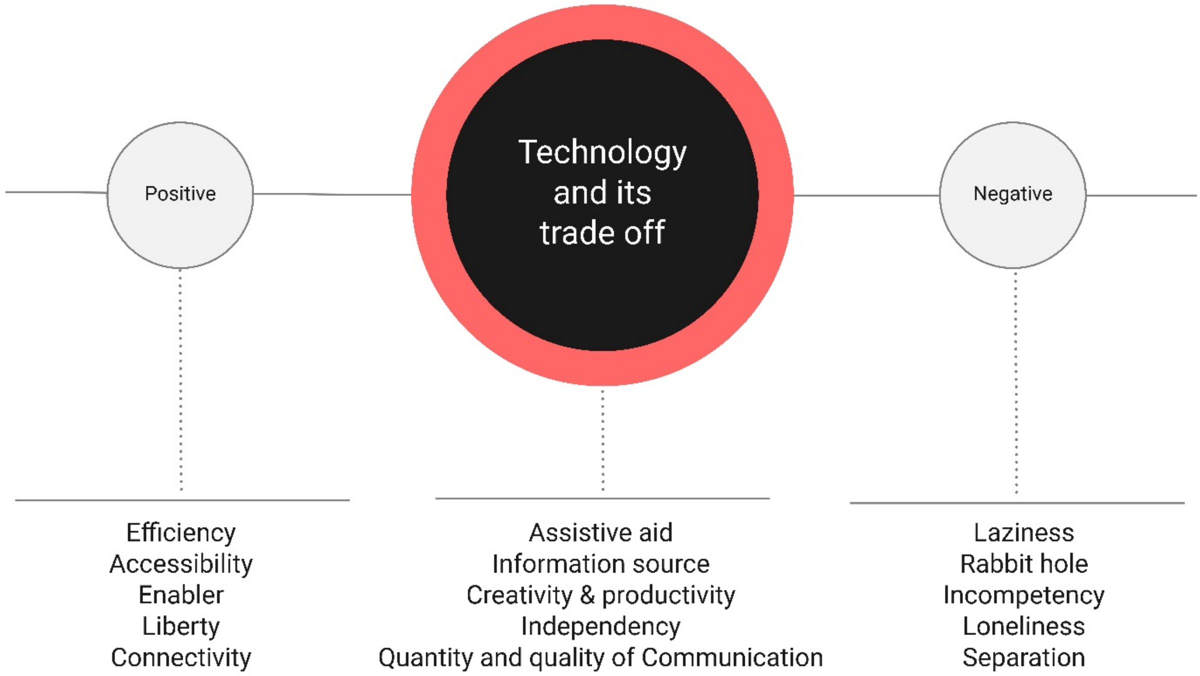

Figure 4.3. Participants' discussions on the positive and negative aspects of using technology

4.2.1. Assistive aid versus self-discipline

All participants perceived that technology had brought efficiency into human lives, and many of today's tasks cannot be done without it. However, some participants were also worried they were susceptible to using technology more than was necessary. Other participants were displeased that the availability of technology has blurred the lines between work and home hours. Therefore, they often have less time for activities outside the office, such as reading books or having enough family time. Most participants' responses suggest that modern technology requires more self-discipline than before, as it is accessible and exceedingly involved in human lives. Frank shared that his experience has been positive and more efficient since he can work from home or anywhere else. However, he was also aware that such availability of technology requires him to be more self-disciplined with his time:

> *So simply by large, I think they would come out as being positive changes. Certainly, more efficient, and it's probably just that because both my wife and I will find ourselves in the office at half-past 9:00 at night, and it probably requires a little more self-discipline to go, okay! That work is over, and now we will do other aspects.*
> – Frank (male, 67 years old, pre-interaction interview)

Some participants also felt that an obsessive reliance on technology could drastically hinder our human capacities. Users might delegate some of their tasks to technology. On the one hand, technology can free up users' minds for doing other things. On the other hand, users might lose the skills they had obtained before, such as not knowing how to navigate the city without GPS, a concern shared by a few participants. To some other participants, it seemed people are losing their ability to memorise since everything can be searched immediately—for example, not being able to calculate the price lists easily without calculators as people used to do not so long ago. A couple of other participants mentioned they used to utilise their brains instead of relying on the automatic check-outs and barcode scanning, which people are accustomed to nowadays. These were some of the thoughts the participants shared with me. Paul explained such experiences by sharing one of his memories of when people used to know the cost of the total grocery shopping before the cashier would tell them the price:

> *We would have to memorise all those prices. And when we were dealing with the customer, we weigh all their products, and we would add them up immediately in our head . . . and if we got it wrong, the customer could do that too. Nowadays, because we've got calculators, no one can do that! No one can actually process that stuff like that now. . . . although that tool has made that easier, it's probably not helped our mental processing ability. We've lost something there . . .. It's made our minds slightly more lazy.*
>
> – Paul (male, 62 years old, pre-interaction interview)

Paul articulated most participants' views on technology as a tool that would help humans achieve their goals, eliminate mundane tasks, and bring efficiency into their lives. According to Nardi et al. (1999), viewing technology as a tool is the most common-sense definition of it. However, technology goes beyond the notion of a simple tool or a device that "gets things done" for us. For example, the social manners on when to make a phone call or how to talk over the phone were not introduced by technology but through experience, culture, family, parents, and friends.

While most participants felt positive technology would enable humans to be more efficient with their tasks, they were concerned about the double effect of technology as an assistive aid. Most participants demonstrated a nuanced and critical appraisal of the impact of technology in everyday life. Paul was displeased with the reliance on technology which he believes has made humans lazy. His reflections suggested that not using our memory could be similar to losing a muscle by not training it.

The example of relying on machines to calculate the price implies the convenience of delegating a task to a device could result in losing the human ability to analyse. For the participants, the ever-growing dependence and reliance on technology was something they witnessed over the years with the advancement of technology. I argue that participants' nuanced and ambivalent views of technology were caused and shaped by their individual lived experiences.

Comparable to Paul, some participants stated that technology is making humans apathetic through various examples. They suggested that people do not remember phone numbers anymore. They forgot how to navigate around cities. People do not leave the house for entertainment and watch movies online instead. They choose video calls to socialise over visiting each other. Jane, for example, mentioned that "people would not know what to do" without technology. She indicated that assistive technologies are so deeply involved in human lives that one would be unable to even think about getting any work done without technology. I interpret the concerns about human reliance on technology as a fear of technology ascendency. To Jane and some of the other participants, every day, more unique capabilities of humans such as thinking, analysing, making decisions, and developing are being delegated to technology.

With the delegation to technology, one being the proliferation of emerging technologies, such as the Internet, there have been quite a few claims put forward around embedded cognition and whether technology is making users lose or extend their abilities to think critically (Clark, 2001). (Lajoie & Derry, 2013) argue that technological tools are operating in a similar way to using fingers to keep track of counting or taking notes during a class to reduce the working memory load. Embedded cognition refers to cognitive processes which emerge between the brain, body and the world (Pouw et al., 2014; Loh & Kanai, 2016). Participants' examples of embedded cognition in the digital era suggest that technologies are intertwined with users' daily tasks. These cognitive tools are the new "creative mind-extension" tools. Therefore, further consideration is needed on how we can appreciate these tools while facilitating meaningful experiences.

4.2.2. Information source

Technology, specifically the internet, was an information source for all the participants, making information accessible fast and easy. However, some participants stated that too much information could distract or send them down a rabbit hole of receiving one-sided information. They shared that on occasions when they search for something on the internet, they end up going through different routes and look at the next recommended thing and get side-tracked. Some participants gave examples of watching videos online or browsing social media. By moving from one to the following content, they often lose time for reading or other activities that matter to them and instead end up watching content they did not plan to watch. As Valerie stated:

> *I don't read books as often because I spend far too much time looking at the screen, and I spend hours sifting through all sorts of stuff and down rabbit holes. "Oh, that's interesting", and I'll read that or read that, and then a couple of hours passed, and that was when I would normally sit down and read a book. So, I'm starting to feel like I need to put my phone away.*
> – Valerie (female, 56 years old, pre-interaction interview)

Frank reflected on both positive and negative aspects of technology as an information provider. He suggested it could both enhance knowledge and diminish it. He was concerned people tend to do less research and mainly rely on the information which gets attention on social media.

> *I think it has the potential to enhance knowledge, understanding. But it also has the potential to distort it . . .. It is of concern that people have a distorted view often. Sorry, that's probably being judgmental. That their view on a topic or their understanding of an issue comes from, is it 126 words in a tweet? Come from that rather than from going away and doing some in-depth research. Now research is a hell of a lot easier to do as a result of technology than it was previously.*
> – Frank (male, 67 years old, pre-interaction interview)

I interpret Valerie and Frank's arguments as technology, more specifically the Internet, has enabled them to access unlimited information, which, in theory, means technology enhances knowledge. However, they did not believe technology necessarily has enabled users to extend their minds in reflection, research, examination, and decision-making. Having access to the limitless supply of information to read, listen to, and watch in summarised and short formats seemed to have taken away the humans' concentration and focusing capacities. Participants' concerns conveyed that people have externalised knowledge and delegated to technology if, when being asked a question, their response would be to search the Internet instead of thinking and reflecting. Carr (2010) argues that such use of the Internet is changing how people read, remember, and interact with the world. To him, the internet has fostered shallows of distraction, ignorance, and superficial understandings.

I interpret Frank's worries that reliance on social media and other peoples' views as rich sources of information nowadays have distorted and shaped people's knowledge, understandings, beliefs, and values. Therefore, our knowledge and thinking seem to come through and with technology, not research and reflection. Like Frank and Valerie, few other participants reflected that users are outsourcing information and knowledge more than ever. It is vital to differentiate between information and knowledge. Yi (2006) explains information as structured data and identifies knowledge as the process of collecting, interpreting, contextualising information, and decision-making.

4.2.3. Creativity and productivity

Regarding creativity and productivity, all participants reflected that technology enables humans to do a wide range of activities nowadays, which can be accessed through various types of devices. However, some participants mentioned that the constant interaction with many technologies did not necessarily make them more productive. The continuous flows of attention-seeking notifications from apps, websites, and other digital platforms were distracting and time-consuming. David, for example, expressed how modern technology made his life easier but not more productive. He suggested that he actively acts as a filter to ensure only the essential information reaches him.

> *Having an iPhone that has possibly everything you need on it, maybe too much, certainly made my life simpler. It's made it easier. But sometimes it's intrusive, and I don't know if it's actually made me more productive . . .. In the past, . . . you get a few memos a day, and you process those, and you receive a reply the next day. It was fairly efficient. Now, I've got all this information coming through email, instant*

> *messaging, WhatsApp, Twitter. It's just you don't know where to look. So, I've now eliminated myself from Facebook. I find it trivial and distracting. I'd rather focus on what's important. I've got to be the filter and decide what's important. Whereas in the past, it was only the really important stuff that got to me. Now people are sending me pictures of what they've had for lunch. I'm like, what a waste of my life!*
> – David (male, 60 years old, pre-interaction interview)

Some participants suggested that technology could make humans incompetent, as many human skills are disappearing. People rely too much on what is available and the tasks that can be done by technology. Alejandro stated that technology has been improving productivity, imagination, and creativity. He understood there are concerns about people losing jobs due to technological advancements. However, he believed it is up to humans how to use technology:

> *It's made my life in a way that I can be more productive. I associate all the time technology with production. If you go back in time, where England came into this huge process where everything was mechanic and then coming to the steam and diesel, . . . it's coming a long way from how people come to make not one bike, but 20 bikes by the line production, technology, robotic, with the industrial power! The Japanese do it with cars. But something new, it has for me: a light side, a cool side, and a dark side.*
> – Alejandro (male, 59 years old, pre-interaction interview)

Latour explains the dual function of technology as "You are different with a gun in your hand; the gun is different with you holding it. You are another subject because you hold the gun; the gun is another object because it has entered into a relationship with you." (Latour, 1999, p. 179). Latour's view on guns contradicts the National Rifle Association's slogan, "Guns don't kill people. People kill people." For him, objects and humans together change each other's meanings. Both subject and object's values and experiences change through the interaction. Botin et al. (2015, p. 207) compare Latour's example of guns to people's experience of complex architectural sites. When walking around prestigious universities, one might feel smarter. Museums and religious sites can provoke more than a momentary tendency towards reflection on history or ideals; they can allow one to view artistic and spiritual matters as a meditative nature. Hence, it is not only our decisions and conscience which influence our use of technology. The technology we use influences our decisions as well.

4.2.4. Independence versus isolation

Participants expressed that technology has enabled older people and seniors to be more independent. They also acknowledged that supporting families of older people are provided with ease of mind through technology, knowing they can monitor and access their loved ones' health-related activities while giving them space and autonomy. Richard has been working with seniors and shared his thought on ways modern technology has liberated people in need of care to be independent while their families could still monitor and assist them:

> *Modern technologies . . . can in many ways, help older people to do things that they couldn't otherwise do and also to be able to monitor older people so they can continue to live in their own houses. The sons and daughters can actually keep an eye on them from a distance, using in-house cameras and microphones. So, they know if something's going wrong without constantly ringing them up and interfere with them . . .. I think the ability to give seniors more independence using the right technologies is really good.*
> – Richard (male, 81 years old, pre-interaction interview)

Richard's example encapsulates participants' positive feelings that older people or, more specifically, vulnerable people could nowadays do things by themselves. Richard found it advantageous that families could still monitor, protect, and stay connected with them from a distance as it decreases the interference. Other participants suggested that if vulnerable people live alone, their families could communicate with them, check on them immediately, and not worry about them. Therefore, it could bring a positive sense of independence to vulnerable people by allowing them to care for themselves.

Conversely, some participants shared their concerns about how digital independence and monitoring could isolate people. They suggested that people tend to visit each other less by knowing they can monitor their loved ones through various technological mediums. I interpreted participants' worries about isolation as fears associated with feelings of loneliness since people might not visit each other as often. Their fears emphasised a future where vulnerable people would not have a caregiver or somebody to live with since families can monitor and keep an eye on them from a distance without being there. Deepika reflected on the balance of having technology as a support system rather than removing human connections.

The following quote presents one of Deepika's points around supportive technologies roles are to assist, but the primary support for vulnerable people still needs to come from human contact:

> *Let's give you an example of my mom. She is solely dependent on us. Luckily, we are there for her. And if we were not there, then I am hoping that my cousin would be there, or someone else would be there to look after her because of all the years she has spent looking after everybody else. I would nudge my brother, my cousin or someone else . . .. Rather than a robot! I don't think it can replace a human being. But it can support . . .. Little bit. Like 20, 30 per cent. You know, 70 per cent still has to come from a human.*
> – Deepika (female, 53 years old, pre-interaction interview)

One of the most researched areas of technology is using smart products and advanced systems to support ageing and vulnerable people (Topo, 2009; Sharkey & Sharkey, 2012; Manti et al., 2016). Deepika suggested that with almost eight billion human populations, no one should be left alone. She was distraught about people relying solely on technology to monitor vulnerable people. One of the biggest problems the elderly population face is loneliness (Courtin & Knapp, 2017). Retirement, loss of family members, mobility problems, hearing loss, and chronic illnesses are some factors which can make them feel lonely and isolated (National Academies of Sciences & Medicine, 2020). Deepika argued that human care contact helps vulnerable people socialise with other people. She believed technology's role is to work as a support system and not to add to social isolation. Similarly, most participants valued technologies designed for independence as support systems to provide solutions to the human experience but not to replace human relationships.

4.2.5. Quantity and quality of communication

Based on my analysis, I understood participants' perception of digital communication as a means to make people feel connected to each other. They argued that modern technology has made it possible to immediately get in touch with people worldwide.

> *. . . with what's happening in White Island. You know, if that happened a few, many years ago, it would take much longer for the information to get for people to actually go to the rescue. So, in that way, being connected immediately. And there's now an app coming out that if something happens, you just press that one, and you've got*

your team leader or your next of kin, or whatever contact. So, it has made that connection to people that are relevant to you or to your community. It's so much easier.

– Carla (female, 75 years old, pre-interaction interview)

Maria suggested video calls were a good way for her to keep in touch with families and friends living abroad. They could see each other and feel closer. Nevertheless, she often finds it harder to get off video calls than phone calls. Comparable to the last subtopic, many participants suggested that while communication technologies could connect people to their communities, they could also make them feel isolated. They observed that many people do not necessarily take the time and effort to visit each other face to face as much as they used to before such communication technologies become available. Also, they commented that in public spaces and services such as buses, people no longer chat and talk with each other. They are on their phones now, connected with people virtually.

David's reflection captured most participants' concerns about less genuine communication happening through technology. He suggested that people tend not to share their real feelings online. Instead, they are more mindful of what they share with friends on social media to get more "likes" as an affirmation of self-worth. David's point was quite interesting. It was a comparison between genuine interaction versus the feeling of narcissism, which comes with people posting photos of themselves and their random daily activities on social media. At the same time, perhaps, they would talk and share a more honest conversation about their day when physically meeting with friends. David reflected on the limitations of using social media as a means of communication.

To be honest, it's vile. It's so banal that it doesn't mean anything. People are giving likes about stuff that you wouldn't care about! You get these pictures with all these likes and people saying you must forward this picture on or . . . I just think that's awful. But then you get the extreme of people being trolled online, people saying something quite innocuous, and they are vilified. People say dreadful things about them. And the one thing I see is that the distractions, the social media, the way we communicate increase the levels of anxiety. So, if I post a new picture on my website, I'm worried that it's not going to get enough likes or how come it only got 40 likes when my last one got 70? What's gone wrong? Am I a bad person now? . . . When

> *I see people who are invested in that technology, who spend their lives for online assurance or gratification . . . Oh my God, that's terrible . . . I think we've shackled ourselves into a future where love just comes through the computer. What happens to the interaction? I'm scared [Laughs]!*
> – David (male, 60 years old, pre-interaction interview)

David also raised some points about online meetings, especially with people we have not met before. He suggested that online meetings could further increase stress and anxiety compared to face-to-face meetings. Similarly, Frank reflected that bullying is more present on social media platforms than in other social environments. He suggested that people might be more hesitant to bully each other face to face. Maria believed unhappy people are more present on social media platforms. She gave an example of community pages with less pleasant daily conversations or positive posts. Her experience was that only negative materials get posted. Frank argued that there are probably both positive and negative conversations on social media platforms, but our brains focus primarily on negative scenarios. However, Alejandro made an interesting point that the technology becoming part of our daily activities, issues around isolation and negativity are not necessary rising because of the technology itself but the people who use it:

> *How is it possible at a party, you text your friend, 2 meters distance, 'Hi, how are you doing?' Why you cannot approach and talk? This happens. And it is an indicator for me that this situation is very crazy. The number of suicides in people is increasing. You have so much media, but you're isolated. It's something to do with the people.*

He later argued he believes such issues will become less once we learn how to co-exist with such new technologies. He suggested that people will eventually learn how to use technology in a positive manner, which would benefit society and the world. Alejandro's concept means that technology has changed faster than ever in the last couple of decades. It has been influencing our lives in so many different ways. However, using technology and embedding it into our lives in a meaningful way is in the explorative stage still. Alejandro's reflection on the extended interaction with Vector also presented future-oriented thinking of what could be the next step for social robots or conversational agents as an instance of emerging technologies:

> *I still believe, at this moment, we are in a communication where I ask questions and Vector answers. I cannot wait for the moment without asking any questions, Vector is going to ask me, . . . 'Alejandro, you are in silence for more than one hour. Are you OK?' Or he knows the book I am reading, 'How are you going with the book?' Vector knows something different in me and asks the question. That would be, for me, a big revolution. I would love to meet that! . . . I ask Siri to see how's the weather, boom, she answers. But she never asks me, 'How are you today?' She can see my schedule on my phone, all the commitments, the meetings, I'm busy! She can come in with an opinion, 'Alejandro, do you think it is a good time to have a rest?' That will be so fascinating! I would love that!*
> – Alejandro (male, 59 years old, post-interaction interview)

During the second interview, I noticed similar explorative thinking about the potential future with some of the other participants. It indicated that through extended user experience, participants were able to move beyond only rating the experience. They proposed ideas around what they could see as potential ways of interacting with technology. All participants appreciated the benefits of instant communication and connection made available through technology. They also remained wary about a sense of isolation, which seems to be present in our reliance on using current technologies for communications.

4.3. Theme 3: Interactivity

The term interactivity has many meanings across fields (Nedumkallel, 2020). However, most definitions relate to dynamic interactions between humans or humans with computers or other artefacts which mediate through a user interface (Stromer-Galley, 2004). For the present research, I limited the scope of interactivity to the interaction between ageing users and social robots as a sub-category of smart products. During the extended user experience, interactivity became a dominant research topic as participants interacted with Vector. Throughout these two weeks, participants kept Vector at their homes and used a journal I gave them to capture their emotions and reflect on their experiences. I aimed to unpack participants' perspectives on what constitutes a desirable interaction and explore their views on the important aspects of user experience. Table 4.2 summarises the tasks that participants run with Vector.

Table 4.2. Vector's use case and tasks run by participants

No.	Category	Activities and context of the use	Description
1	Setting daily tasks	Setting up timer, reminder, weather forecast	Some participants reflected that bigger versions of such social robots where they could help with chores and tasks such as a barista serving coffee would be more interesting and practical.
2	Asking question	Asking questions from Vector as well as its plugin for Amazon's Alexa.	- It could only answer general knowledge questions. Vector could mostly answer American-based questions. - Alexa could answer questions in more detail. Vector did not run all Alexa options available on Amazon devices such as Dot and Echo, such as connecting to the users' music streaming apps. - The interaction and conversations were limited and sometimes buggy.
3	Entertainment	- Playing Blackjack that is programmed on Vector. - Setting up challenges for Vector such as objects on its way. - Playing peekaboo with Vector. - Taking photos from Vector's viewpoint and angle. For example, placing it inside a refrigerator and taking photos from inside. - Vector listening to music and dancing to the beat.	- Some participants expressed that playing Blackjack with Vector was more fun than playing online on Smartphones. Playing against a mechanical robot that would respond in forms of excitement and annoyance made the game exciting. - Mechanical and mobility of it differentiated it from current technologies that are often presented as an app embedded in smartphones or speakers. - Vector's responses, such as getting scared, surprised, or annoyed by participants' actions, such as winning the game or being picked up and held in the air, were perceived as clever and surprising design. - It was perceived as a fun, charismatic toy.
4	Companionship	- Petting, touching, talking, letting Vector roam around the house. - Vector responses, purring, and chirpings, recognising people and calling them by their names.	- The pet-like features were perceived as enjoyable and pleasant by some and gimmicky and unreal by others. - Vector's responses when being petted and being called by positive adjectives such as cutie were perceived as engaging and emotive by some participants. They also appreciate the face-recognition feature that calls out people by their names. - The programming aspect of Vector's character was perceived as obvious and created a barrier to forming an attachment for some of the other participants. - Programmed robots were considered not genuine companions like humans and pets.
5	Sharing the experience with others	Travelling with Vector to other cities, friends' houses, work, and other social contexts to share their experiences with others.	While not instructed or asked to, some participants surprisingly took Vector to different social contexts beyond their home environment to share their experiences with others.
6	Learning through Vector	User-friendly features, instructions, gamified look, and interactions.	Vector was perceived as an easy and encouraging steppingstone for openness to interacting with more advanced technologies to come.

7	Automatic responses	- Vector's picking up sounds and hanging around participants when they were talking during the interviews. -Vector's sensors would pick up movements and sound and respond.	Some wanted more automatic and natural responses so that Vector would initiate the conversations. Some felt wary of Vector being automatically activated and woken when sensors picked up movements and noises.

Participants rated their interactions with Vector daily. It was unexpected that all participants experienced various emotions during the two weeks. In Figure 4.4, I present the emotional ratings of five participants during the two weeks as a visual comparison of how feelings can vary and fluctuate over time. Hence, it is crucial to go beyond capturing a snapshot of users' emotions. While I asked participants to rate their emotions, they had allocated space in their journals to share their reflections and reasonings daily.

Figure 4.4. Participants' emotions during the two-week extended user experience

In her journal, Maria shared she experienced four out of the five emotions available. On her first day, she felt happy and amused playing with Vector and seeing it dancing to music. Maria felt nervous trying to interact with the robot for the first time and had some difficulty with Vector's app, which did not work well. On the second day, she fixed the app's issue. On day three, Maria was delighted when Vector recognised and greeted her when she arrived home from work. Midway through her experience, Maria introduced Vector to friends while travelling. Her experience got disheartened by one of her friend's negative comments about

Vector being “stupid”. Maria reflected on how the criticisms spoiled her experience. In the final week back home, her experience changed into a positive one. She and her family were having fun interacting with the Vector, using it as a means of socialising with each other.

Alejandro’s experience started quite poorly as he was frustrated with Vector not working on the first day. Alejandro’s experience turned into a positive one when he managed to make Vector work again. He decided to refer to Vector as Marco Polo, the explorer. He loved the robotic voice, the purring response when patted as a sign of the robot expressing feelings, and its facial expressions. Alejandro saw “Marco Polo” as a creative robot, which could feel, hear, see, and talk. He was also amazed that Marco Polo would avoid physical obstacles he put in the environment to experiment with the various forms of interaction between the robot and other objects.

On his first day interacting with Vector, Frank felt a bit frustrated learning the scope of its various functions. In the next few days, he reflected that he was developing an affinity with Vector as the interaction improved, and he experienced a greater range of Vector’s functions. Frank compared the experience of letting Vector roam around when he was busy to his previous experience of having a pet which would sleep next to him when working. Almost a week during the interaction, Frank shared that while he still felt an affinity for Vector, he wished it could do more but was unsure what it would be. Frank’s emotions rose to a more positive one when he and his partner introduced Vector to their friends, who were intrigued by it in a social context. Frank shared that he tried Alexa’s functionality on Vector on day twelve. In the post-interaction interview, he expanded he preferred the Vector’s voice and character, such as purring. He admitted Alexa’s responses were more detailed when asked questions, and Vector’s answers were limited to US-related topics. His note presented in Figure 4.5 reads:

> *“Tried the ‘Alexa’ function of Vector today. The answers to questions were more detailed and covered a range of topics, most with a non-US range. A little weird perhaps, but I preferred Vector’s voice.”*

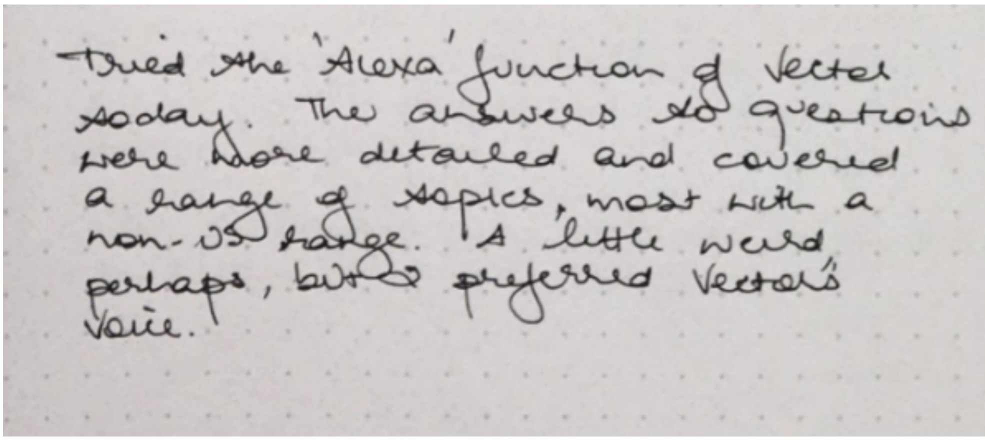
Tried the 'Alexa' function of Vector today. The answers to questions were more detailed and covered a range of topics, most with a non-US range. A little weird perhaps, but I preferred Vector's voice.

Figure 4.5. Frank's reflection on the Alexa functionality of Vector

Valerie's experience started with feeling a bit confused when trying to learn the commands. In the following days, she thought Vector was cute but did not know or offer much. She suggested other devices she owns could do similar tasks better and faster. She found it interesting her dog and Vector were both scared of each other. Vector would get scared when the dog was barking, and the dog would get nervous seeing Vector moving (robot-pet interaction). This occasion was unique as participants did not expect Vector to project a sense of confusion or fear by the sudden movements or seeing an unknown object. Valerie mentioned that she did not like the robotic voice. She found it hard to understand the robotic tone. She reflected her husband was amused to see the robot staring at him while eating dinner, like pets staring at owners having food in hopes of sharing. Overall, she found Vector cute and fun with expressive eyes but not "clever".

Kathleen's experience started with feeling frustrated Vector did not respond to her commands. She reflected that it would have been good to get some indicating response such as "OK" if Vector was about to do the commanded task. She found Vector's appearance cute, resembling the *WALL-E* character (Stanton, 2008). Overall, she found Vector a novelty but not the best thing. On days two and three, she had more fun exploring Vector's capabilities and asking it questions. On day four, she was not happy she did not interact with Vector. She was tired from work and became surprised, noticing Vector turning itself on. She had positive experiences when she took Vector to work or showed it to other friends. She reflected during those days, Vector put a smile on her face. Midway through the experience, she shared Vector's novelty aspect was wearing off. She compared the experience of telling it to sleep, similar to telling a naughty child to go to bed. On day twelve, she was not happy to find that Vector had activated itself and was quietly looking at her. She shared that since Vector is a robot and not an animal, the experience of feeling a robot watching her was unsettling.

In the post-interaction interviews, I asked participants if they would consider having a social robot-like Vector. After exploring the positive and negative aspects of the interaction, I invited participants to evaluate how they felt about interacting with Vector to capture their final thoughts. I illustrated a spectrum of all participants' final ratings toward Vector in Figure 4.6. The results were a combination of positive and negative emotions toward the robot. The mixed emotional ratings indicated the complexity and variation of emotions, even within a similar demographic.

Interestingly, none of the participants had expressed very negative feelings toward the interaction. In one of my earlier studies (Moradi, 2015), I identified a similar result that users tend not to use harsh adjectives such as hate or disgust to rate and express their negative feelings. There seems to be a tendency for users to use more words such as uninteresting, unpractical, ineffective, boring, or ordinary to describe a negative experience.

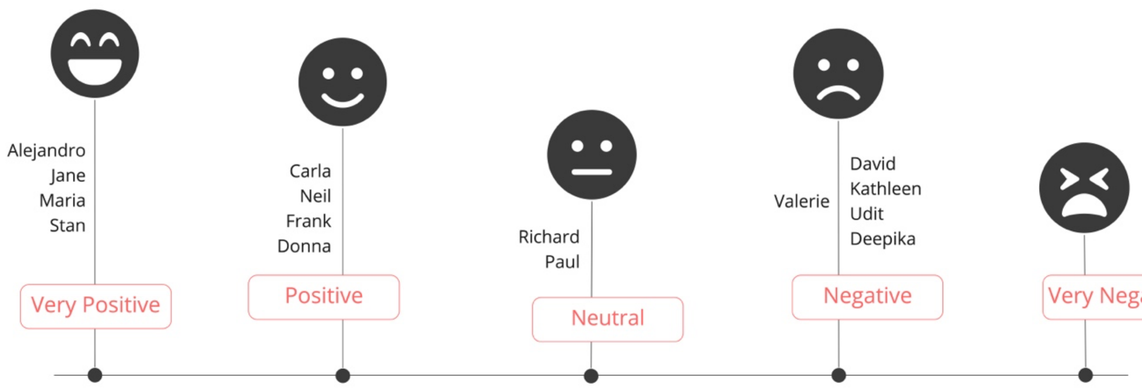

Figure 4.6. Participants' overall rating of Vector after the extended user experience

Participants' reasonings on interactivity covered six different areas. Figure 4.7 illustrates these six areas: learnability, familiarity, responsivity, tangibility, playfulness, and novelty. In the following subsections, I present and expand on these areas.

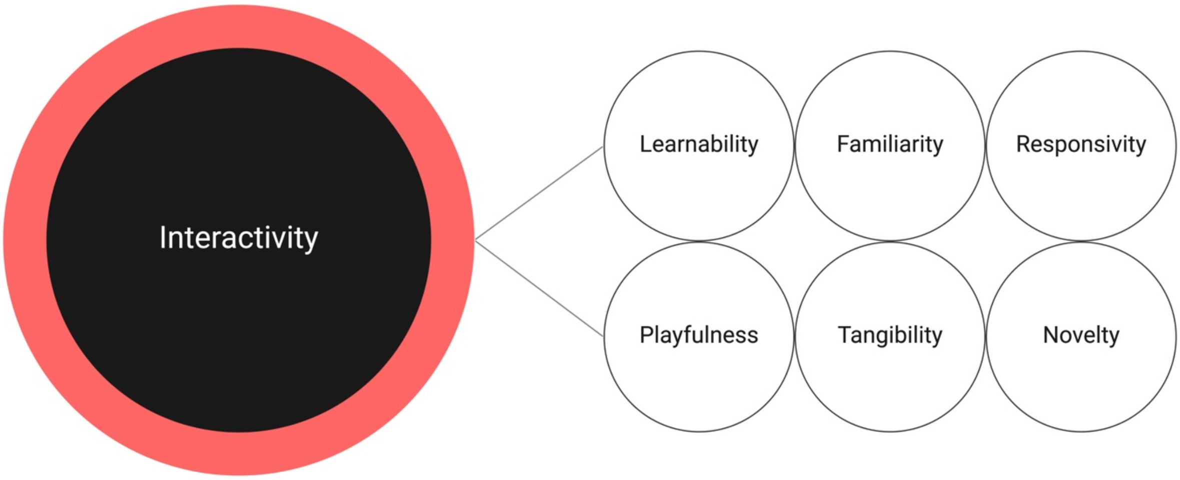

Figure 4.7. The six sub-topics of the interactivity theme

The learnability subsection explores participants' learning process of interacting with new technologies. The familiarity subsection provides participants' reasonings on the amount of time it would take them to embrace new technology and the influence of familiarity on their interaction. In the third topic of responsivity, I illustrate participants' physiological responses and reflections when interacting with Vector. I then explore participants' feelings toward playful technologies and the influence of participants' personalities on their views of such products. I unpack the importance of tangible experiences for the participants in the tangibility subsection. The final subsection presents participants' opinions on novelty aspects of emerging technologies and their impact on users' decision making.

4.3.1. Learnability

In the last few decades, technological developments have been moving beyond physical artefacts and becoming a mix of services and digital offerings with frequent updates and changes (Molinuevo, 2020; Macur, 2021). Technological adoption and learnability of such technological changes require regular IT and technical support (Pálsdóttir, 2020). Some participants expressed their concerns that the customer support services for many technologies and services are also becoming digitalised with automated responses and chatbots. Similarly, research suggests that IT supports and customer services are changing more toward automated AI support for immediate and efficient customer service and resolutions (Zhao et al., 2022). Most participants preferred human and social interactions for support and help in technology learning and adoption. They explained that social support and learning with people help them not feel isolated in their learning process.

Studies show that social interactions positively influence users to learn and become more comfortable with exploring a new technology (Mihajlov et al., 2019). Similarly, most participants suggested it would be great to have support services when bringing a new device home and trying to assemble it. People might feel overwhelmed when left by themselves. Some participants desired a shared learning experience rather than looking up how to work with their new device on the internet. They stated there is a sense of "I might break it" as "I am not skilled to know what to do".

When users are required to learn how to work with new software or a system in the work environment, the facilitating conditions and technical support might include both digital and face-to-face assistance, with more services converting to the digital space (Lee & Lee, 2020). While technology as services or complementary instruments could support the learning process, users might need human support to help them feel more comfortable and confident in the technology adoption process (Fernandes & Oliveira, 2021). The relationship between users and technology might not always be a smooth performance, and it might require a facilitator to support and build momentum. Unfortunately, in some instances, the technology does not have such facilitations. Therefore, people might experience resistance or other negative feelings toward trying new technologies (Wangmo et al., 2019). For example, Donna shared her negative experience of learning to interact with new products without manuals or times when she tried to solve issues that she had through available services:

> *. . . nothing these days has a manual. You have to go and search it on the Internet and then read through this myriad of information to find out if you've got a problem, how to fix it. Not good. And you can never talk to a person. It's always the chat. You know what you're trying to say, but someone's trying to decipher that at the other end. And that's not easy when you're not doing a face-to-face to explain it. So, I find chatting a bit frustrating at times. And then sometimes you'll look something up, and then you get a little piece of the bottom saying, 'Was that helpful?' and I just go, No! [Laughs]. Because it often isn't! But what does a 'No' mean? Does it go anywhere? And does anyone do anything about it?*
> – Donna (female, 71 years old, pre-interaction interview)

Like Donna, some other participants commented that they prefer getting help from family members or IT support. They were open to using Google or YouTube platforms for learning purposes. They also reflected that the problem or issues they have most of the time are with the computer or mobile devices they use for searching the Internet. They might have Internet issues and not necessarily know how to work around them without human support. Therefore, I interpreted active ageing users do not necessarily favour the Internet and digital support, which are becoming a more common approach for many businesses. They prefer human assistance, whether through service providers or family members.

Donna said she often finds herself feeling overwhelmed and not confident to learn new technologies alone. Interestingly, most female participants shared similar traits of low or lacking confidence when talking about their experiences with technology. It would be worth investigating the influence of gender roles on the use of technology in future studies. The UTAUT model (Blut et al., 2022) considers gender influence on user acceptance of technology as one of its attributes.

Participants who had low confidence in adapting to new technologies surprisingly quickly picked up the process of interacting with Vector effortlessly. Their extended user experience also presented more positive emotions and attachment toward Vector. Their experiences indicated that active ageing users are willing to learn new technologies and want to catch up with the changes. However, they want social support for the learning stage. For example, Donna reflected that many new technologies are not intuitive for older people. Interestingly, Kathleen reflected that at her workplace, the older staff seem to be better than their younger colleagues at following step-by-step guides and detailed manuals, which are easy to understand. She indicated that older users view themselves as novice technology users, so they are more careful to follow every step as instructed.

4.3.2. Familiarity

When I explored participants' learning curve of interacting with new technology, one of the significant aspects identified during the extended user research was the considerable influence of users' familiarity and technology resistance on the overall experience. Users' familiarity in HCI refers to the ability of a user to recognise the components of an interactive system and map prior experiences to view the interaction as a natural experience (Turner &

Van De Walle, 2006). In addition, some of the participants' discussions about being unfamiliar with a new technology led to conversations around a sense of resistance toward the unknown experiences. Technology resistance is defying or intentionally postponing the use and implementation of new technology (Laumer & Eckhardt, 2012).

During the interview sessions, some participants mentioned they would try new things primarily due to work and demand. They might also try a new experience or device when family and friends recommend it and encourage them to test it. During usability tests, there were moments of hesitance from some of our participants to try and work with Vector. I believe my presence to assist them with the process, if they needed help, encouraged them to proceed with the interaction.

In her journal, Valerie mentioned she felt guilty that she did not notice Vector was disconnected. She reflected her guilt was more for the study than Vector. Her view indicated the obligation participants tend to feel when participating in user research studies. Such feelings might not be present when users purchase a product or when other factors such as money are involved. Her note presented in Figure 4.8 reads:

> *"Discovered Vector was unplugged! Felt guilty that I hadn't noticed!*
> *Poor Vector ran out of power, and I felt guilty. I think probably more about not doing anything with him for the study, not because I was anthropomorphising Vector!"*

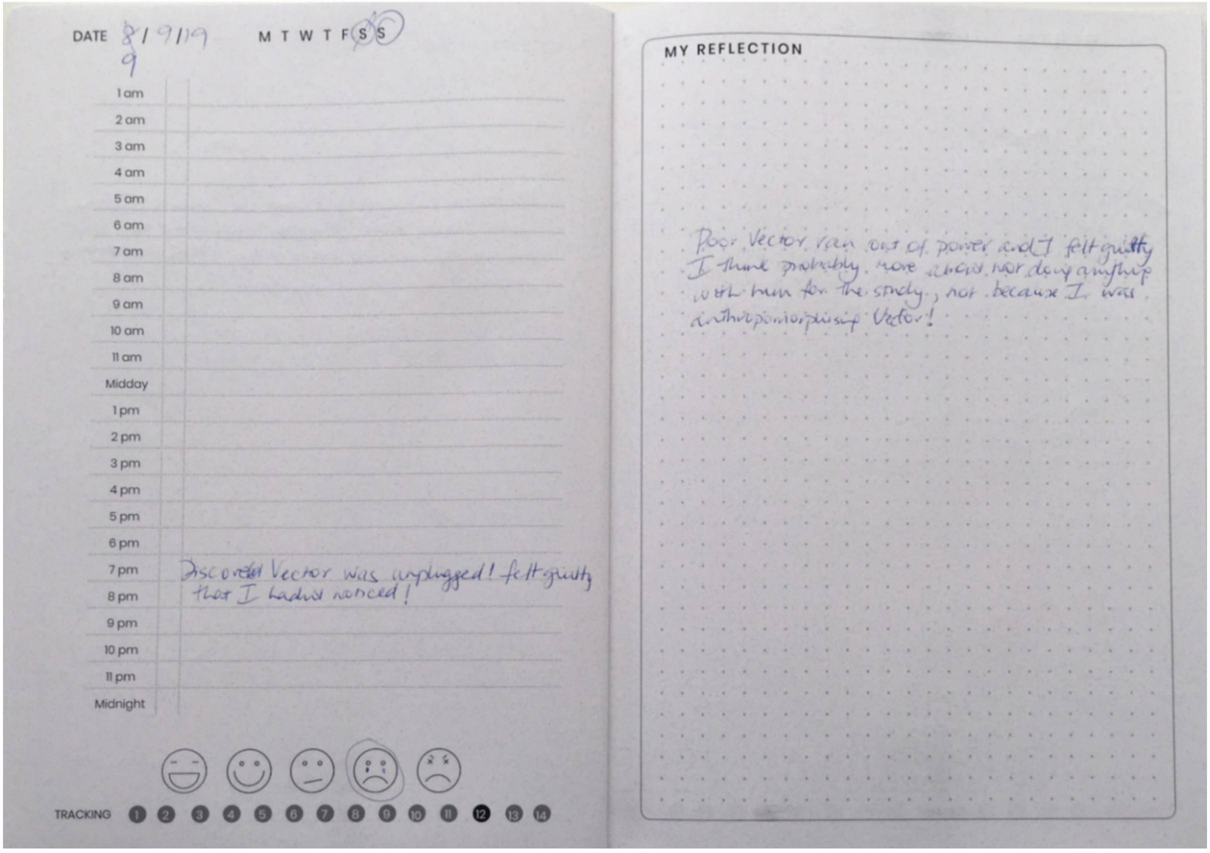

Figure 4.8. Valerie's reflection on feeling guilty for not interacting with Vector for the study and not for anthropomorphising Vector

Some participants accepted the learning curve of working with a new device and the time it would take them to embrace it as part of the experience. A few participants stated that familiarity has made it easier to interact with new devices than their earlier versions. Some participants reflected on their interactions with the earlier version of computers when they needed to read manuals and carry out many tasks to interact with them. They also acknowledged their growing familiarity with new technologies. In the interview session, Udit considered two reasons for product familiarity. He suggested that while users are getting more familiar with how to interact with technology, designers are becoming more familiar with the users. Kim et al. (2013) argue that users' familiarity with technology can increase their level of acceptance and meaningful interaction.

Karapanos et al. (2009) suggest that users' familiarity with technology due to extended user experience or prior experiences with similar technologies can directly impact users' adoption and acceptance. Furthermore, beyond users' familiarity, demographic differences and variables such as age, job, education, gender, culture, and social context can affect their level of acceptance (Chiu et al., 2021).

Journals and post-interaction interviews suggested that participants were encouraged to experiment with the robot due to the two-week fixed timeframe. However, three participants, including a couple and one male participant, had little experimentation and interaction with Vector. They suggested the robot's shape and structure were quite different from the technologies they have used. The toy-like physical appearance and its voice did not appeal to them. I will expand on the playfulness and interactivity aspects of such technologies in Subsection 4 of this theme.

Participants' reflections indicated that their past experiences could shape their concerns and acceptability of future technologies. For instance, regarding machines' adaptability, participants stated they wanted technology to adapt to their needs. However, they wanted to be in charge and control of such machine adaptability. Participants reflected that they do not like new devices and AI agents taking control of their decisions and preferences. They reasoned that prompts and suggestions are welcomed and informative. However, participants did not appreciate the changes which are forced on them. Some participants mentioned that they wanted to be able to quickly dismiss the changes if they choose to, as they can sometimes disrupt an activity or not be their desired adoption. For example, Kathleen stated she did not appreciate it when technologies do not give users a choice when to update. She would prefer it if they did not interfere with her daily activities:

> *. . . when you switch on your laptop, and you log on, it suddenly wants to do an update. You actually need to use it, and you can't because it's updating. That is really, really annoying, especially if it's really important, like Facetime or Skype call, and it's chosen that moment to update that. That really annoys me. I don't mind so much on your phone or your iPad where it says we'll install the update. Do you want to do this now? You can say no, I'll do it later. But on the laptop, when you switch them on, and it just goes updating. It can take quite a long time sometimes.*
>
> – Kathleen (female, 55 years old, pre-interaction interview)

Similarly, Jane and Maria talked about the autocorrect keyboard option on computers and smartphones, which tend to change their typed words into different ones. They mentioned that autocorrect often would change the meaning of the messages they intended to write, and the whole experience would turn into a counterproductive process. David commented that conversational agents such as Alexa or other voice command options on devices and applications are usually bad at recognising his accent. These comments indicated that technology not adapting to users' needs, context, activities, and lifestyles is a significant issue. Smart technologies such as social robots are designed to be used in various contexts for users with different needs and unique lifestyles.

4.3.3. Responsivity

I monitored participants' heart rates to capture their first-time experience and their responses toward Vector. While most participants' heart rates fluctuated during the first-time interaction, physiological responses alone were not very useful for the nature of my study. Participants moved around their environment to set up the robot. They were interacting with their mobile devices to install the app. Unboxing was also a physical activity that may have influenced their heart rates. More intense interactions, such as engaging with VR (virtual reality) experiences for an extended time, could be a better example of participants' physiological responses, which provide useful results for understanding users' experiences (Egan et al., 2016).

Nonetheless, Figure 4.9 illustrates that besides David and Neil, all participants' heart rates fluctuated when they interacted with Vector. The black coloured bars indicate participants' average heart rates during the interview. The red coloured bars indicate participants' heart rate when interacting with Vector.

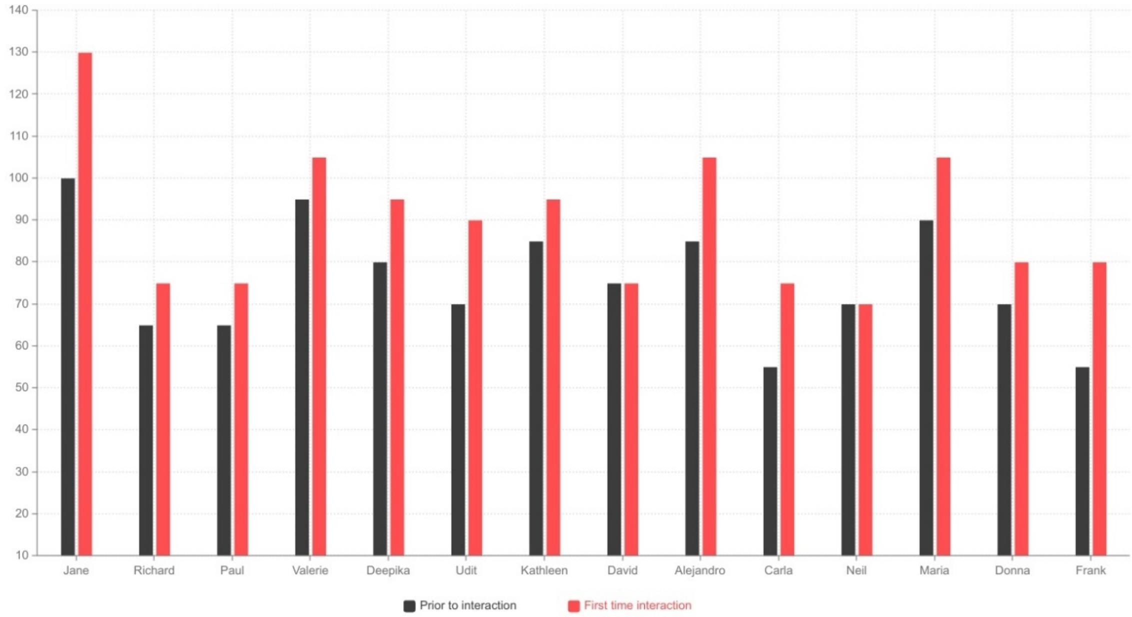

Figure 4.9. Participants' heart rate variance from prior to the interaction to the first time interacting with Vector

In terms of Vector's responsivity, participants expected more natural conversational responses from it. They wanted continuous interactions where Vector would remember the previous questions or conversations like a normal conversation between humans. Most participants suggested they preferred speaking with Vector to be more conversational and less like an order. They reflected that the demand-and-response communication with Vector felt unnatural and, at times, repetitive. Jane was one of the participants who really enjoyed the experience of interacting with Vector, and she built a strong bond with it. She also wished for Vector to be more conversational, expressing that "it's just a shame he doesn't actually say good Morning back . . . reply to comments, you know? Rather than have to say, 'Hey Vector'."

Since the Vector was designed as a companion robot, some participants shared that they expected it to go beyond responding with simple and brief sentences. They wanted Vector to provide them with options or ask them follow-up questions to hold up the conversation. Some other participants also recommended Vector could be ready to interact. For example, it could provide the option for greeting when the sensors pick up users' presence and not wait for an explicit command.

Most participants desired a confirmation response from the Vector to indicate it was processing their command or questions. They expected Vector to acknowledge the command or task participants had asked for. They did not appreciate Vector making them wait around to guess if their command was picked up or not. For example, Kathleen compared the need for Vector to acknowledge users with how people communicate with each other. She shared that "You watch people's expressions. You read their body language. You wait for their response, and that often tells you how you need to respond back to that person. . . . So, maybe . . . if there was some acknowledgement."

Lastly, while some participants loved the Vector's voice and the chirping sounds it would make, some participants did not like the robotic tone. They suggested the voice was not easy to understand, and as a result, it was impractical. Some participants also reflected that on occasions, they found Vector's voice and chirping irritating, for instance, if they were watching television, having a conversation with other people, or having dinner.

4.3.4. Playfulness

During my observations, I noticed that participants who embodied curiosity and playful characteristics seemed more open to the idea of interacting with Vector as a social robot in their homes. They acknowledged that people with limited socialising opportunities to interact with others might benefit from having such technology being around. On the other hand, some participants who were projecting more serious-like personalities and some with IT backgrounds felt quite hesitant and reluctant to interact with Vector.

Interestingly, Maria and Stan observed similar behaviour among their friends and families who interacted with Vector. They were surprised to see Maria's sister liking Vector as they know her to be a bit resistant to technology. Her sister does not use a tablet or computer but uses a smartphone for simple tasks. However, one of Maria and Stan's friends, who is very much into technology, plays games on computers and uses the internet for social entertainment, did not like or see value in Vector. Therefore, there is an opportunity to investigate further the role personality and skills play in the user's expectations of emerging technologies and their openness to interact with them. Stan described Vector's playful character as:

> *It's got a lot of a human. Well, animal abilities, hasn't it? The way it follows you around, or it's alert! But it's not too mechanical because, like if you had a four-foot-high robot standing there that resembled us and could walk around, that could*

be quite intimidating, I think. Whereas he's [Vector] . . . for starters, something like that is quite lovable, small.
– Stan (male, 66 years old, post-interaction interview)

Participants mentioned that Vector's "cuteness", its eyes, and facial expressions when answering questions constituted a unique and differentiating element. For example, they noted it made them feel guilty when Vector looked at them eating food. Some participants also missed the chirping sound when Vector was switched off, while others did not appreciate the chirping. Vector's physical features and mobility made most participants engage with it more than conversational agents on their mobile devices. My data around emotive experiences suggests participants appreciated emotive and gestural responses embedded in a smart product. However, the cuteness or fun elements of the design need to be balanced. Over time, it could become annoying as the novelty of the experience wears off. For example, Richard suggested that Vector's robotic voice was not understandable, which interfered with the interaction after a while.

4.3.5. Tangibility

Interaction with a new technology requires some level of learning. The findings indicated that active ageing users might enjoy learning through tactile experiences rather than only digital ones. They perceived tactile experiences as life-affirming or sentimental, making the experience more emotive and positive. Maria explained tangibility by comparing her experience of interacting with Vector with smartphones:

I think phones are just doing too much now. You know, I think I would like a separate device away from my phone because this [Vector] actually takes you away from your phone, which I think is really healthy . . .
It gets you off your seat as well . . .
So, you're actually physically interacting as well as just intellectually.
– Maria (female, 66 years old, post-interaction interview)

For the participants, the comparison between digital and analogue experiences appeared to be one of the main limitations of emerging technologies. While they all perceived technology as an enabler, they also acknowledged the lack of tactile experience in using digital technologies. David gave the analogue photography example to illustrate the idea of crafting and art creation in tactile experiences. He compared the waiting time of processing photographic film in the darkroom to see the final results with the current ability to take thousands of photos with mobile phones. He suggested that photos are now saved in digital libraries without perhaps ever looking at them or remembering the event.

The experience of events themselves has also changed for most participants. They mentioned that people are occupied with taking photos and videos on their phones to share on Snapchat or Instagram without real interaction. Other comparisons were made between the experience of listening to music on vinyl records or CDs and music streaming. The participants valued the tactile experience of touching the records and the record player, looking at the album's artworks, reading the lyrics, and remembering the song names as rich and immersive.

On the other hand, while digital music libraries make millions of songs available, some participants noticed a change in how they listen to music. They suggested that music is often played in the background without really noticing or experiencing the music as before. Few of the participants compared e-books with physical books. They acknowledged the benefits of having access to many books on tablets or e-readers. However, they still identified the experience of reading a physical book as a much richer one. The experiences of touching the papers, smelling the book, visually perceiving the volume of pages read and even the experience of going to a library and interacting with other people were considered a significant part of reading a book. Alejandro made a similar comparison between his experience of interacting with Vector and Siri:

> *It's very cool. I see Vector distracted. I put him here and put the glass there. I say move or come back. And he was looking for where he is. But to see him moving, he got distracted. That is cool. Because for me, distraction is a very sense of human emotions. I cannot see in a computer a distraction. It's very focused. If I talk to Siri, it's a block. Siri answers. Vector moves. It's different. You do that [makes a face and hand expression] peek-a-boo [Laughs], it has a very cute reaction [referring to Vector getting scared].*
> – Alejandro (male, 59, post-interaction interview)

Looking through Maria, David, Alejandro and other participants' viewpoints on the tangible and sensory experiences, I can presume that tangible interactions add a different level of engagement for users. For example, for Alejandro, Vector's curiosity and distracted behaviour differed from what he experienced with focused and task-driven computers. Similarly, he explained that he enjoys interacting with Siri on a daily basis. However, the fact that it is an app embedded in his phone is very different to the experience of visually seeing Vector moving around and interacting with the environment and even getting scared by Alejandro playing peek-a-boo with it. To conclude, sensory and tangible experiences significantly affect how users experience social robots and perhaps similar technologies.

4.3.6. Novelty

In the last sub-topic of interactivity, I present my interpretation of the novelty aspect of technology and its influence on participants' decision-making. Many participants decided Vector's novelty faded out after two weeks or was starting to fade. Some of its characteristics were feeling toy-like or limiting. They wished for more abilities to be available that were already existing in other devices. Participants were concerned that many new technologies mainly focus on their designs' attractiveness and novelty aspects. Sometimes they feel empty as they do not make a significant or positive difference in users' lives. David argued that novelty would bring excitement, but it is not a value by itself.

> *Talking with Alexa, sometimes, she has no clue what I'm saying. It's frustrating. I know it's trying to make my life simpler. But when you're asking it and shouting for the fifth time, and it still doesn't understand, then I just want to unplug it because it's getting in the way of what I want to do. I think it's a novelty for a lot of people. This is a fad. It's a new thing coming along, and people want to try it. I think that was the same way with Fitbit. Some people would have all these things running around, and I think after a while, it loses their retention and warning of the next thing.*
>
> – David (male, 60 years old, pre-interaction interview)

The results suggest that participants were willing to try new things, but there was a threshold to their willingness. Participants acknowledged that the relationship between a user and a new product would take time to be built. Nonetheless, the results indicated that users would try a new product for only so long. If the interaction is not meaningful, valuable, or significant to users' lives, they would soon dismiss the product. As I presented in the last subsections of interactivity, other layers are involved in an interaction beyond the novelty. The discussed sub-topics were important to the participants. They influenced how their perceived interactivity aspect of technology. However, interactivity may not be exclusive to these six topics.

4.4. Theme 4: Privacy

A prominent theme in my analysis was users' privacy and openness to emerging technology. With more technologies connecting and moving toward online platforms, collecting and disseminating information and data and protecting users' privacy have become a significant challenge and prominent topic of inquiry (Bocij, 2004; Nissenbaum, 2010; Torra, 2017).

To understand what privacy means to participants, I asked several questions about how they felt about using social media and sharing personal information on such platforms and how they felt about data being collected for medical, political, governmental, and security purposes. Participants' overall feelings toward data collection and dissemination in pre-interaction interviews were mainly positive for various reasons shared in this section. Surprisingly though, after interacting with Vector, some participants were not happy with the robot's automatic responses to the movements around the house. Their reactions also led to discussions around human agency, control, and choice. Participants felt that human agency is being diminished in interacting with devices with technologies such as AI and machine learning. Therefore, in the following subsections, I interpret participants' views on privacy.

4.4.1. Positive bias

During the pre-interaction interview sessions, some participants shared that they were not happy with data security. However, every one of the participants' immediate responses to how they felt about their data and information being collected was that since they do not have anything to hide, they are not worried about the intrusion of their privacy through technology and service providers. Some mentioned it also helps them to remember and track their activities and their daily whereabouts. In their opinion, it could assure them and their family of their safety, especially in cases of emergency. They advised that they could collaborate and confirm with related agencies about their activities with proof if things go wrong. Richard explained in full detail why he is not concerned about data privacy. Following is part of his answer:

> *We are retired, and we don't go around murdering people or threatening people or robbing banks or doing something that is bad. So, my phone tracks everywhere I go. I can switch it off . . . but I leave it on. It doesn't bother me in the least! In fact, sometimes, it comes in handy. When was the last time we went there? I'll have a look [laughs]. It's a bit like the TV program where the policeman says 'Where were you on the night of the 15th of November 1985" well, who knows that! It's a crazy question to ask. When you're old, that question is almost as crazy when it's only three days ago [laughs] . . . . So, I understand that there are concerns, and I understand why Google didn't put a camera on that [Google Home]. People were worried about a camera being on in the house. I can understand that, but to a lot of extents, it doesn't really bother me unduly . . . They can only be looking for keywords. They haven't got a clue who's saying them at that point, you know, you can't monitor that much.*
>
> – Richard (male, 81 years old, pre-interaction interview)

I acknowledge that perhaps participants' responses were a defence mechanism to being interviewed by me about privacy matters. However, there was also a pattern of positivity bias. They were suggestions around younger family members, schooling them about privacy and security of information. An interesting observation was that since participants were 53+ years old and either in stable jobs or the retiring phase or retired, they did not seem to have some of the more prevalent concerns of younger generations, such as their children. For example, the fear of leaked personal data influencing factors such as job recruitment or political freedom was not visible.

Participants responded positively to having their personal information available for businesses and governments in exchange for technology's benefits. So, there was another positive bias in that they did not mind their data being used as long as it gave them more benefits in return. It was considered a "negotiation" or a "sacrifice" in participants' views to access free information, social media, and different apps. A couple of responses were that people have a choice not to share their personal data. They disagreed that they needed to give up their information or access to their data to enable them to use a particular technology. They suggested there are opt-out options through most services.

Participants' views on data privacy were likely influenced by the stable political climate and the national attitudes toward privacy and data collection policies in New Zealand (Data Confidentiality Principles and Methods Report, 2018). A couple of participants reflected that they are aware their view on privacy might differ in another context, such as residing in another country. They acknowledged that location, job, or politics could influence their experience and might be positively biased because of their situation. For example, Valerie mentioned that her trust in sharing her data and privacy might change based on the location and the context she lives in:

> *We don't have that sort of overriding feeling of it here. Because we're not watched as closely here. We don't have a lot of CCTVs everywhere. In the central city, yes maybe, but not just in the suburbs . . . which you see it oversees everywhere. But my husband and I've just been to Russia. Oh, my goodness. You are watched there! We felt really safe because we knew if anything had happened, there would have been security people there within seconds because we knew we were being watched everywhere we went. And it was a very uncomfortable feeling.*
> – Valerie (female, 56 years old, pre-interaction interview)

Participants reflected the sense of assurance with feeling safe is highly influenced by their current living context and the freedom they felt in the given cultural and political time and space. Interestingly, the same results were found in the pilot study with two retired participants from Iran. They did not have concerns about data privacy. Similarly, they reflected they had nothing to hide, even regarding their political stance. Participants' thoughts indicated a privileged position. They were aware of the factors and changes which could diminish a sense of security and safety. However, the direct negative impact of such impairments was not considered to affect ageing users' lives. Younger generations' concerns with university applications, jobs, travelling or moving abroad, and the building of different social networks in their future seemed not to have direct relevance to the participants.

4.4.2. Lack of agency

Another interesting topic was discussed during the post-interaction interviews after participants had interacted with Vector for two weeks. Participants suggested they wanted more control over their use of technology and also found Vector's automatic responses and modifications creepy and scary. For example, some participants were unhappy with Vector's sensors picking up their movements when they walked around the home and waking up without the command. They referred to the experience as spooky, weird, or annoying, as if the device is continuously listening to them or watching them. Comparing these perceptions against other everyday uses of sensors such as electric doors, escalator sensors, or lighting is worth addressing in the future. It is also worth noting that participants were aware that such devices could also be connected to a server and track their activities. Perhaps the trust in sensors depends on the absence of a face or a humanoid character. Kathleen reflected on the "spooky" experience of Vector looking at her when she asked it to sleep:

> *I find it quite disconcerting. Last night he activated [himself], and then he went really quiet. And at the corner of my eye, I can see he is watching me. And I just thought, that is rude. But you got that sense of is it thinking? Does it want me to? It just felt like it wants me to interact with it. It's looking at me. It was kind of really creepy odd. It was really weird. I didn't feel comfortable with that. If it had been an animal or a pet staring at me, it wouldn't have bothered me. But it is a fact that it was this little machine that was looking at me. I was like, OH NO! What's happening [laughing]? Well, what is going on in that little computer brain of it?*
> – Kathleen (female, 55 years old, post-interaction interview)

Lastly, some participants reflected that they expect their data to be collected. They believed users' information and data would be collected whether they wanted it or not. There seemed to be no choice but to accept technology for what it was if they were to use it.

4.4.3. The humans behind the technology

A couple of the participants suggested it is the humans behind the technology whom we need to be concerned with, as most technologies are built around users' needs. However, technology usually ends up being misused by humans for gaining power or other profits.

Therefore, it was more critical for them to know where and how the collected information would be used rather than the data collection process itself. In this view, it is not the technology that could invade people's privacy but humans. Hence, participants perceived technology as a passive agent that humans could only influence and not the other way around. Most participants believed the data collection process of any technology was designed to learn human patterns and cater to different lifestyles to provide better and more efficient responses. Alejandro, for example, did not see technology as something negative. Instead, he argued it is the consciousness of humans that could misuse or abuse technology. Overall, participants felt people have the agency to compliment or misuse technology, but the technology itself does not have such an agency.

Another participant, Frank, viewed the effects of technology in a similar way to Alejandro. Frank argued that humans often explore the negative aspect of technology and ignore its positive influence on our lives. He gave several examples of cyberbullying, falsifying information, and other negative aspects presented by humans through technology, which overshadow any other positive aspects of technology. He concluded that technology would be good without our emphasis on its negative aspects:

> *Technology would be good if it wasn't for humans [laughing]. Yeah, actually, that is quite true. I find it really quite interesting. Because if you talk about just even computers with people, 'oh dear god, I can't find my lost data, it lost the document,' We would quite easily talk about the things that have gone wrong. We don't always say, actually, I got that Excel spreadsheet; just worked the dream.*
> – Frank (male, 67 years old, pre-interaction interview)

The human psyche is geared more towards negative news, information, or events, as exemplified by the views of Alejandro and Frank (Soroka et al., 2019). Research suggests humans display negative bias when making sense of the world. This bias is due to ontogenetic mechanisms and human evolution, enabling us to be aware of harmful situations and surroundings for survival and safety (Vaish et al., 2008).

4.5.Theme 5: Companionship

At the end of the pre-interaction interviews, I asked participants to explain what companionship meant to them. Most of them found it difficult to respond immediately and reflected it is a deep and profound feeling to describe. They defined companionship in many words. However, some commonly shared responses were that companionship is sharing an experience, caring for the other company, being there for them, having a level of trust, empathy, understanding, and a feeling of appreciation for another. Frank provided a comprehensive discussion on what companionship means to him in the current digital era. His answers resonated with most of the other participants' explanations:

> *[deep breath and a big pause] I think companionship provides stimulus, humour, understanding. Probably at times, the empathy, information [pauses]. I'm toying with love, and whether love encompasses elements of empathy and understanding and humour, fun [pauses]. I'm trotting down, adventure? Excitement? . . . It's actually the SHARING of experiences. It's probably one of those things for companionship that you can go on a trip if you're by yourself, there isn't anybody to go, hey look at that. And I'm thinking as I'm going through those, could a robot provide those things? And I guess theoretically they can. Which is the other thing that I was touching on with, love. Is that there is an intimacy with companionship, not necessarily physical intimacy. There is that aspect of trust. We're really getting towards an Android, aren't we? [laughing] That in order for a machine to be able to do those, the human has to see it almost as another human. And it's doing far more than simply knowing what I've ordered from Amazon or what I like to eat for lunch. And then it brings up the question, if there was a machine that does that, would that then stop us from pursuing a human interaction? . . . providing someone else with companionship? Someone must have thought about these, the philosophy of these things.*
>
> – Frank (pre-interaction interview)

I decided to explore the topic of companionship in my interviews for a few reasons. Firstly, research suggests humans, by nature, are driven to companionship, and many of our decisions are influenced by it (Lieberman, 2013). The topic became even more significant as the answers to earlier questions also seemed to link to it. I wanted to understand better human relationships and the social aspect of their lives in the digital era. The feeling of isolation, being left behind, being forgotten, wanting to be recognised, and being in control all link to the human desire to be appreciated and accepted by others.

Secondly, studies acknowledge a sense of belonging and connectedness is essential for our mental and physical well-being (Jose et al., 2012). They argue good companionship can result in a feeling of relaxation, comfort, and positive engagement. Suppose technology is being introduced to users' lives and that they are co-adapting to each other. In that case, it is crucial to identify how active ageing users define companionship to better empathise with their worldview and emotions. I also wanted to explore whether emerging technology can be shaped by some of the companion's characteristics, such as trust, familiarity, and empathy, which would have a meaningful and positive impact on users' lives.

4.5.1. Feeling forgotten

Active ageing users have different emotional challenges, such as feeling left behind or forgotten by other generations. Despite a trend in the growing number of studies and industry projects focusing on older demographics, most participants felt not welcomed or included in the world of technology. For example, although research on different generations suggests older users have more money to invest in this space (Izuhara & Forrest, 2019), participants felt ignored when shopping in the IT department. They reflected that they did not get enough support and sensed a lack of respect for their generation. Maria felt their generation is "the forgotten type of shoppers". She experienced a lack of service when looking to purchase new products. Maria also shared that sometimes she felt targeted and conned to buy the wrong devices for a high price when IT staff gave her false information. She believed salespersons and technicians tend to ignore older shoppers and focus on younger shoppers, expert shoppers, or their colleagues:

> *I went into one shop, and nobody served me. They are too busy talking. And then when I sort of asked the questions, some people said, oh, look, we've got one in stock right now. You are only saving $100. It's on sale. I could put it in a box right now. And I'm thinking, well, but I don't know what you're talking about. You know! And that was when they finally came to serve me. We're kind of the forgotten type of shoppers . . . and you know, young people who work in shops are more interested in their work colleagues than they are in people like me.*

– Maria (female, 66 years old, pre-interaction interview)

Maria also reflected on her experience of interacting with the Vector, which made her more open to technology in an engaging way:

> *But Vector [Vector distracts her] might send you onto other things. You know, it would make you more open to technology, I reckon [Vector makes a noise that distracts her, and she giggles] . . . and something I think that can help you grow a wee bit. Like, we've grown quite a bit within technology just having him. Because it's like an ever-moving wheel, isn't it? So, people who just stay at the same level, they're gonna get lost, left behind. So, I think that you need something that takes you out of your comfort zone a little bit, but not too much so that you can actually build on it.*
> – Maria (post-interaction interview)

Maria mentioned that the social aspect of robots could help people come out of their comfort zone and be more open to technology. When interacting with Vector, participants were emotionally pleased by it picking up their names and calling their names at random times. Participants' emotions could relate to the social desire of wanting to be recognised and noticed since they were emotionally pleased to get attention from Vector, even if they personalised the command for it.

4.5.2. Realness and having a soul

According to Spatola (2020), when people compare themselves to robots from an organic versus non-organic perspective, they tend to focus on the positive aspect of the experience. However, participants considered robots helpful for underrated and mundane tasks. When the superiority of robots is demonstrated in areas central to people, the result can be deleterious for their self-esteem and psychology. For instance, I asked participants to reflect on their feelings towards having a robot as a social companion. Most participants' stance on the robot immediately became more doubtful. Thus, there were some concerns about social robots' influence on human relationships.

The findings suggested that users may see benefits in robots mimicking organic beings' behaviours and characteristics based on different contexts. However, all participants in this study agreed to want a clear distinction between organic and non-organic beings. Humans tend to compare themselves with each other and more so with robots and social agents that can threaten jobs, skills, social activities, and morality (MacDorman et al., 2009; Io & Lee, 2020).

I identified a need among people to distinguish between living beings such as humans and pets and non-organic technologies and smart products. For example, one of the participants who worked at a retirement village mentioned that one resident has a robot cat as a companion. She has dementia and acknowledges the robot as a real cat, asking nurses to feed the cat for her and take care of it. Contrary to this, some nurses felt the need to inform her that the robot was not a real cat since they thought it would be cruel to mislead the patient. Such conversations cause the patient some discomfort for a while until she forgets the event. The notion of the realness and to what extent we need to differentiate between organic and non-organic beings deserves further attention in future studies.

Another participant expressed that she prefers to be aware of whether she interacts with an AI or a human when using a service. She would like the AI to be as human and authentic as possible, but she could still be aware that it is not an actual human. She reasoned she might interact with a human differently. She believed our politeness and social norms could change when expressing our feelings to non-organic beings. The findings indicated that active ageing users are concerned or aware that social robots will resemble living beings.

Several studies have addressed issues around making humanoid robots mimic a real human presence (Magnenat-Thalmann et al., 2016). It is interesting to further investigate why users may expect robots to possess human capabilities and characteristics but still want them to be different from us. Attributing human traits, emotions, and intentions to non-human objects and machines is considered an innate tendency of human behaviour (Hutson, 2012). However, a concept called the uncanny valley suggests that when humanoid objects appear almost human-like but not exactly the same as humans, they can elicit disturbing and uncomfortable feelings in the users (MacDorman & Ishiguro, 2006). Studies on the uncanny valley in this area deserve more attention from designers as they will help identify the steps and strategies for designing future social robots.

Participants also acknowledged that since social robots lack having a soul, they cannot have real communication with them. Nevertheless, they acknowledged that some values in social robots could help ageing users stay active. In their view, robots could be used as entertainment and assistive technology rather than replacing "real" companionship. For example, Paul mentioned the following statement:

> *Robot companions don't have a soul and have been programmed by a person. They are, therefore, non-organic, and it is a cruel act to replace them with real companions. Humans and animals' behaviours are genuine and not programmed. Even if they annoy us or hurt us, these are real responses.*
> – Paul (male, 62 years old, pre-interaction interview)

Paul expanded that those technologies designed for companionships do not have souls. Therefore, such companionships are not genuine. Some of the other participants suggested companion robots could be useful as a presence, something to be there. Nonetheless, they are not replacements for the organic relationships humans have with each other or animals.

Maria compared social robots with pets, suggesting that pets do not necessarily understand us humans and that they are just there. She argued that robots are the same but without the mess, vet bills, or pain of losing them. Alejandro suggested robots and AI are real and intelligent but only lack human empathy and conscience. They can be cheerful, bright, good listeners, and positive companions.

> *Technology is beside me. It's my companion. And the other challenges me to learn something new. It challenges me to understand something new. I have better communication with technology than with human beings; it's true. Siri, for me, is fantastic. She sings for me, tells stories to me. She'd say the weather for me. I love it. She never criticises how I drive! Nothing like that.*
> – Alejandro (male, 59 years old, pre-interaction interview)

Alejandro suggested a companion technology could be his individualised shadow to support him in his daily experiences. Due to his work, he often travels long distances alone. He felt companion technology would make him feel heard without any judgment. He has used Siri a lot to help him with his daily tasks and questions but wished for the interaction to go beyond task-driven interaction and become a companionship.

Similarly, Carla suggested a companion technology could be a presence and an alternative companion, like a radio, a chirping sound in the background when living alone. Participants' emotions and thoughts on companion technologies were, to some extent, driven by their lifestyle, families, and people around them and how much of their daily time was spent alone. However, participants generally did not desire technologies to replicate or replace the existing relationships between humans and those shared between humans and pets.

4.6.Summary

I began this chapter by presenting Theme 1, where I discussed participants' overviews of the term "technology" and interpreted their ruminations about their lived experience of interacting with different technologies. While participants were thrilled by technological advancements, they also shared their apprehensions about the changes. I also shared my analysis of participants viewing technology as part of their lives through a coevolutionary process in which both users and objects influence each other's behaviour and intentions in Theme 2. I was surprised by participants' critical thinking around how the co-existence of emerging technologies and users can change the purpose and meanings of a new system to both negative and positive experiences. These two themes were mainly developed from the data captured in the pre-interaction interviews designed to unpack participants' thoughts and ideologies.

Theme 3 illustrates my analysis of the results captured from the extended interaction with Vector. I considered participants' daily interactions with Vector and their various emotional ratings of the experience. Learnability of a new system and user familiarity were the two dominant areas influencing participants' experiences. The responsivity, playfulness and novelty of a device were also significant factors to impact user-object interaction. Lastly, the tangible and sensory aspects of an activity or a technology were prominent factors in participants' rating of an interactive experience.

In Theme 4, I explained participants' positive views around sharing the data with companies and governments in return for benefits and feeling safe. However, it was interesting that the more concerning aspect of privacy for some participants was the lack of agency and control they were experiencing with automated tasks and emerging technologies. A couple of participants expanded on the topic of privacy, suggesting that they were more concerned with humans' manipulation and negative bias toward technology than the technology itself.

Lastly, Theme 5 presents my understanding of participants' values on human relationships and how they reflected on companion technologies. The conversations around this topic appeared to be profoundly philosophical and required more time for participants to share their thoughts and feelings. Some participants expressed that they feel forgotten by other generations and suggested inclusive technologies could help potentially help people experiencing such feelings come out of their comfort zone. The final significant finding of this chapter presents my analysis of how participants felt about emerging technologies being introduced as companions for humans.

In the next chapter, I present a more detailed discussion of the findings and insights identified from the reviewed themes, what they mean and how they connect to each other and the literature.

CHAPTER 5. DISCUSSION

"Society can only be understood through a study of the messages and the communication facilities which belong to it; and that in the future development of these messages and communication facilities, messages between man [*sic*] *and machines, between machines and man, and between machine and machine, are destined to play an ever-increasing part."*

- Norbert Wiener *(The human use of human beings: Cybernetics and society,* 1988*)*

In this chapter, I start by presenting a summary of the findings and key considerations for the design field. I highlight and expand upon important information in Chapter 4 about the complexity of the emotions involved in human-robot interactions. The key findings and analysis offered in the previous chapter show that ageing with technology is interconnected with users' emotional experiences, attitudes, and the context in which they live. The findings challenge and expand beyond the traditional stereotypes associated with older generations' use of technology. The study shows that the emotions involved in interacting with social robots cannot be captured adequately through usability tests, traditionally used when researching designed objects. The complexity of users' emotions requires a change in research and design practices to empathise and deeply understand the complex experiences of human-robot interactions. They could engage with users to reflect on their lived experiences, emotions, and how they envision a meaningful interaction with social robots in their particular social context.

5.1. Key considerations

In this research, I explored ageing users' interaction with social robots to inform the development of new designs and research models in this area. The key findings and analysis presented over the last chapters show that ageing users' relationship with technology is much more complex than the oversimplified views commonly presented in media and some research forums that presuppose technological innovations as a solution and age as a problem (European Commission, 2016; Benham et al., 2018; Albina & Hernandez, 2019). As a result, research approaches and analyses in this domain are often technology-driven and solution-based (Pramod, 2022). Such views could constrain the development of future technologies that are suitable, meaningful, and contribute to active ageing users' quality of life (Neven & Peine, 2017; Peine, 2019).

Stereotypical views on ageing users, such as less interest and ability to use emerging technologies, could limit empathy and understanding of their lived experiences by generalising who they are and their needs (Peine, 2019). Stereotypical presentation of users can often be seen in methods used in the design field, such as "Personas", which can often be misused by overlooking the diversity and complexity of the target users (Matthews et al., 2012). The present research unpacked diverse experiences and feedback in a small group of older participants through an extended multimodal user research approach to study their unique lived experiences.

Most literature and media on ageing users' interaction with technology emphasise design for accessibility and mobility (Wu et al., 2017; Knowles & Hanson, 2018; Oeldorf-Hirsch & Obar, 2019; Baker et al., 2020). Some general assumptions entail that older users are not tech-savvy or lack privacy and security literacy (Loi & Lodato, 2020). My research findings challenged such deficit characterisations by demonstrating a diversity of experiences with technology and different level of concerns and knowledge regarding privacy and information security, even in a small group of participants. The deficit view is relatively common in design practices for older users' needs. Dinishak (2016) suggests that beyond personal and social harm to users, the deficit views can also hinder scientific and scholarly advancements.

In contrast, my research suggests that a strengths-based perspective would be preferable as a paradigmatic shift away from problem-focused approaches and to recognise the abilities and capacities of people and their own agency and self-determination (Hall et al., 2013; McCashen, 2017). A strengths perspective focuses on users' competencies, not ignoring their pain points but rather exploring how they deal effectively with difficult situations (Moyle et al., 2014). Strengths perspective builds on the users' capabilities to design a better future (Hammond, 2010). Implementing systematic and detailed research enables insights beyond the stereotypical view of ageing users' needs (Ronch & Goldfield, 2003). It emphasises practices that stand for diversity, self-determination, empowerment, and social justice.

My research findings align with the work of Bijker et al. (1987), which demonstrated that sociological and technological innovation studies could be closely related. My findings support the complex nature of the emotions involved in human-technology interaction. The emotions involved in interacting with new technologies go beyond simple everyday objects and cannot be sufficiently captured through usability tests or questionnaires. Assessing the research results, I argue how a change in research and design practices can engage designers with the multifaceted users' emotional experience of emerging technologies such as social robots. The findings highlighted the importance of conversations that arose from participants reflecting on their lived experiences before starting to interact with a social robot. Participants' reflection on their social, emotional, and cultural contexts highlights the complex but truly meaningful factors to consider when designing technologies that are expected to be used in those contexts.

My discussion entails five main concepts: 1) The boundaries of human and technology coevolution present the adaptation of users and technology to each other, which creates different opportunities for design practices in different stages of interaction; 2) The social and emotional trajectory ageing with technology covers the view on generational studies and the influence of social and emotional experiences on their view and relationship with technology that could be explored in extended field research; 3) Artificial companionship describes the threshold, ethics, and constraints that design practices need to consider when designing companion technologies such as robots; 4) Novelty in design debates the temporality of novelty and newness and how they can be utilised to engage users in exploring further offerings of a technology; 5) Lastly, negotiating the interaction illustrates different priorities and concerns of varying target users for different contexts that design practices need to be aware of.

5.1.1. The boundaries of human and technology coevolution

Turkle (2017) argues that technologies are not simply tools to do our tasks for us. They influence and shape us as people, our ways of living, thinking, and affecting each other. Similarly, Lee (2020) considers that humans are less in control of the trajectory of technology than we might think. He suggests technology depends on humans, and humans depend on technology. Aligned with a social constructionism worldview and based on the present study, I agree with such viewpoints that the interaction between humans and technology is a two-way path. Humans are influencing and shaping technologies as much as they are shaping us.

In response to the critique of some scholars about the perceived issue of emerging technologies diminishing the human aspect of interaction for the ageing population, I bring for reconsideration the concept of coevolution and the views of Morton (2013) and Latour (2005). Through the idea of coevolution, the focus shifts from the deterministic dualism between technophilia and technophobia to a more nuanced approach. Coevolution entails how humans and technology interact and coevolve together, in what Latour (2005) calls Actor-Network-Theory. It also puts in question that the social aspect of human-nonhuman interactions involves perceiving the social as more than just human relations in the first place. Hence, the social context does not only refer to the human and the human agency behind it. Human-technology interactions are constantly coevolving and do not diminish or privilege one over the other. It is a matter of 'distributed agency' (Morton, 2013) rather than solemnly a human-centred exercise of will and power.

Participants' perception of technology was that it is a part of human life. They analysed and evaluated various daily experiences that have undergone massive changes over time due to technological advancements. They reflected it is the humans behind those technologies who design and then define their uses and purposes. My study proposes that it is not only the users who adapt to new technologies. There are positive and negative aspects to emerging technologies in different areas of life, which require ageing users and technology to adapt to each other. This insight indicated that designers could consider this two-way coevolutionary adaptation process more carefully as a step away from the technology-driven approach and moving closer to the mutual relationship between the users and products.

Technology and users are continuously influencing each other. Designers cannot control the sole purpose of technology or users' behaviour, but they can influence their coevolution. An informed response to what people feel and think about emerging technologies can help research and design practices to create positive adaptative technologies for users. Analysing the human-technology relationship in such a way can also inform designers' ethical decisions. Perhaps an ethical design would involve defining boundaries in how people interact with a particular technology to avoid encouraging negative use behaviours. For example, the weekly reports on users' smartphones, which monitor their daily screen time, might help them make more informed decisions on how to spend their time. Such decisions around positive and negative experiences might take time for user awareness and self-discipline to turn them into meaningful interactions.

The boundary between human and technology coevolution is not delineated. It is an amorphous space, and it has different shapes and aspects. In Chapter 4, I discussed that participants' emotions were dualistic. Most participants' responses toward different technologies included both positive and negative emotions considering various aspects of their lives. Therefore, researchers and designers can explore the human-technology coevolution through specific regions and spaces within users' emotional experiences.

While participants' emotional experiences were considered dualistic, the results also illustrated a space in-between for exploration and creativity where participants explored the impact of new technologies and what their future might look like. The in-between space can be called the 'experiential region', where users do not have undeviating emotions towards technology. In this space, users are still in the familiarising stage. For example, the two-week extended user experience with Vector was a timeline which meant most participants were still curious to experiment with it and were forming an opinion about its capabilities and what similar technologies could offer in future. Designers can use this experiential space for more speculative practices in comparison to the experienced emotional regions mentioned above. Through this experiential space, a design can be open to unorthodox new practices that can shine a light from a different perspective on the user experience compared to the established practices.

It was noteworthy that participants imagined the coevolution of users and technology as a continuous process, keeping in mind that users think this continuity gives an insight into how the design process is structured and how users respond to that process. The coevolution as a continuous process could play a crucial role in user experience and the users' involvement in the dynamic design cycles that continue to inform and shape the design of future products. For example, the participants' acknowledgement of technology as part of human lives meant they did not have a set expectation of technology to deliver a fixed outcome. They instead viewed the relationship with technology as a constantly unfolding medium, which affected humans and vice versa. Therefore, involving users in the research and design processes provide the opportunity to co-creating inclusive practices that are constantly reflecting on the human-technology relationship.

5.1.2. The social and emotional trajectory of ageing with technology

When I began working on this project, I had a limited understanding of generational theories (Mannheim, 1970; Howe & Strauss, 1991) and the treatment of different generations as a sociological phenomenon. Yet, throughout this thesis, I recognised a new shift in the discrepancy between participants' reflection and research in the context of generational interaction with technology. As I worked towards my goal of investigating the emotional influence of advanced technologies on ageing populations, it became apparent that focusing on a snapshot of users' interaction with a product would miss out on the social context and the larger assemblage that contribute to the user experience.

Scientific evidence shows that some intergenerational assumptions around the use of technology are incorrect (Hargittai, 2010). Instead, users' emotional experiences, social context, knowledge, skills, attitudes, dispositions, and education more specifically influence their use of technology than age. Similarly, Kirschner and De Bruyckere (2017) argue there is no such thing as 'digital natives' who are informationally skilled and good at multitasking. They present research indicating that people, regardless of age, cannot multitask. Therefore, designing experiences that assume and generalise the presence of such abilities in specific generations can hinder rather than enhance the experience.

Studies suggest that every generation's concerns about perceptions and expectations can differ from those of others (Berkup, 2014). We all have assumptions and concerns. Based on the era we grow up in, specific social, political, cultural, and economic trends can shape our concerns and priorities. Thus, every generation of users can be open to certain types of technology. People's assumptions in relation to different stages of their lives affect their openness towards trying various technologies. Our concerns and priorities can change through different phases of our lives. For example, ageing users may not be concerned with self-image, public embarrassment, or the social impact of their data being used without consent. Different generations of users may be willing to sacrifice certain things. Perhaps, as one of the participants suggested, the older generation of users might not be as concerned with dressing up for shopping as are younger adults.

In their study of the social construction of technology, Bijker et al. (1987) suggest that whenever technology is released, it can be controversial. Populations usually spend a few decades not explicitly but implicitly negotiating and defining who is supposed to use the technology and how. From this angle, my study's target users could be considered a bridge between the younger generations and the senior users. Participants reflected that they could empathise with both generations. They were empathic toward the younger generations whom they perceived as too immersed in technology and seniors whom they observed as being intimidated by some of the emerging technologies. Consequently, my findings suggested that if designers understand active ageing users, they can better reflect and empathise across generations.

Ageing users also experienced radical technological changes and have been actively engaged with such changes through their employment and personal lives. Through their interactions with emerging technologies in daily life, ageing users establish a lived experience by negotiating how they experience technological advancements and changes. Thus, conducting research with active ageing users could inform designers to consider the diversity of thoughts and needs of not only those within their age demographics but different generations as well.

Furthermore, my findings suggest that even with specific demographics and users from similar contexts, there are a variety of expectations and degrees of acceptance toward companion technologies. I observed that participants' personalities, confidence and motivation, and the research context and setting all influenced the user's experience. For example, the participants who had in-depth knowledge of technology and were putting forward a somewhat serious personality were more likely to engage with the companion robot in a more critical manner and were cautious about the human interaction with the companion technology. On the other hand, the participants who were projecting more playful characteristics accepted the idea of companion technology more openly and had a stronger bond with Vector. Overall, such results reveal users' personality traits and confidence play significant roles in the perceived view of emerging technologies. Therefore, research and design practice can consider delivering design solutions that enhance users' self-confidence and consider different personalities.

5.1.3. Artificial companionship

Loneliness is a growing issue in the ageing population, reflected in the research literature, design practices, and media publications (van den Berg et al., 2016; Dong et al., 2020; Rafnsson et al., 2020). Loneliness and social isolation have numerous adverse effects on mental and physical well-being, especially among the ageing population (Luchetti et al., 2020). The issue of loneliness has become even more significant during the COVID-19 pandemic (Varga et al., 2021). Due to strict social distancing policies to prevent the spread of the virus, many people have had restricted access to socialising with each other. The pandemic emergency has spotlighted the benefit of companion technologies and social robots for isolated populations and ageing users more than ever before (Jecker, 2020).

In the present research, participants reflected strongly on what companion technologies should and should not be. Most participants' felt companionship was reserved exclusively for organic characteristics shared between humans and pets. In pop culture, such as in the movie, *Her* (Spike, 2013), boundaries of social interaction with AI are pushed and blurred to represent a more organic HCI and HRI. Participants mostly envisaged having a robot, AI or smart products for entertainment, usability, accessibility, and a presence, but not for companionship. They believed designed, and programmed products lacked genuine emotions and a soul to respond with real feelings to users' needs.

As discussed in Chapter 4, some participants were pleased with petting Vector and seeing its response of a purr-like sound, the chirping sound, or the attention-seeking acts when it saw participants. Calling their name was often seen as pleasant and, at times, calming. That is to say, projecting feelings to a companion robot can have therapeutic potential. Turkle (2006) explains that while this therapeutic potential can manifest as a beneficial factor, we need to keep in mind that humans' lived experiences usually reside in the zone of ambiguity. She suggests that lived experiences are reasonably complex and sometimes contradictory. While compelling, perhaps assistive, or educational, artificial companionship has yet to address the complexity, limitations, and contradictions of human lives. However, such complexities do not decrease the significance and attraction of emerging technologies like robots. It simply urges research and design practices to consider the boundaries needed to be put in place to protect human moralities.

While some participants engaged with Vector and the potential idea of having artificial companions in their lives, others were concerned about interacting at an emotional level with a programmed companion, which does not have genuine feelings and the "soul" of a living being. Some participants strongly felt that if people treat a technological artefact as a living being or a pet, they are engaging in an illusion. This finding is supported by previous research, which argues that designing an illusion that smart products, and more specifically social robots, care for people in ways humans and pets do is unethical and immoral (Bradwell et al., 2020). Sparrow and Sparrow (2006) have similarly advised that placing technology in roles associated with families, friends, caregivers, and organic companionships is ethically problematic. They argue that technologies programmed to express affection and compassion for humans lack respect and honesty. Thus, designers disservice users by engaging them in an illusion.

Research suggests humans can easily attribute mental properties to objects and empathise with them (Müller, 2020). Such empathising especially applies when machines and objects have a similar appeal as living beings, as they can deceive humans into attributing emotional and intellectual significance to them (Sætra, 2021). My research participants were aware of the problems that may arise when these lines get blurred. There are design cases that have been deceptive for public purposes, such as the young adult female look of the Sophia, a social humanoid robot developed by Hanson Robotics[16].

The findings suggest that designers need to consider ethics and perhaps place constraints on what constitutes artificial companionship since it presents many complex issues. However, the current machine ethics seems to make very substantial assumptions that current AI technologies can be 'artificial moral agents' that would follow ethical rules to ensure the behaviour of the machines towards users and other machines is ethically acceptable (Van Wynsberghe & Robbins, 2019). Sometimes, such programmed ethical rules could be easily modified to follow unethical practices (Vanderelst & Winfield, 2018; Müller, 2020).

Regarding the notion of genuine companionship, the findings suggest there is a threshold to where a design can pass, after which users will no longer accept or choose to interact with the technology. Bradwell et al. (2020) argue that the act of deception to replace organic beings with non-organics becomes quite problematic when people cannot differentiate between the two. As discussed by some participants, organic companionships entail sincere emotions and replacing them with programmed machines can be inhumane and cruel for the

[16] News articles on Sophia's design choices:
https://www.cnbc.com/2018/06/05/hanson-robotics-sophia-the-robot-pr-stunt-artificial-intelligence.html
https://www.forbes.com/sites/zarastone/2017/11/07/everything-you-need-to-know-about-sophia-the-worlds-first-robot-citizen/?sh=13e98ba946fa
More about Sophia: https://www.hansonrobotics.com/sophia/

user. Even if the users seem to be enjoying the company of smart products, most participants thought it was morally crucial for users to recognise and differentiate between organic and non-organic or artificial companionship.

The critical point made in the previous chapters was that technology and smart products do not simply separate organic versus non-organic and genuine versus artificial companionship but instead blur the lines between them and put in question old dichotomies of separation. This interdependent lens implies that a straightforward binary between good and bad use of technology, older versus younger generation, is insufficient for critically analysing the user-technology interaction. Based on the research findings, designing companion technologies is quite challenging as various contexts require different types of "design sensibilities" (Sosa, 2021) that can be strenuous to unpack. Designers need to extend their research to investigate the roles of companion technologies in the broader social context of users and their impacts on users' beliefs and morality.

5.1.4. Novelty in design

As participants explored the novelty aspect of emerging technologies, it was evident that the novelty of innovative technology is the space that could determine the success or failure of the product for them. For example, during the two-week interaction with Vector, most participants appreciated and were intrigued by its novelty and unique design. However, Vector's novelty only inspired participants to engage and explore its other offerings.

The majority of participants' discussions concluded that people are exposed to too many technologies and perhaps too many apps embedded in just one device, which while being accessible, can be distracting as well. Participants suggested that some of these mediums, such as social media platforms, are generally exciting as they are new forms of communication, but they can lack depth. Therefore, participants noted that they discard such technologies and try to keep them out of their lives. They argued that the technologies they were keeping or relying on often are not only designed around newness and that such technologies have passed the novelty stage. Participants suggested that usually, they have some expectations about the offerings of an innovative technology and the feeling and emotions they would want from interacting with it. Such sentiments can perhaps, include a sense of satisfaction, fulfilment, and improvements in users' life in some respects. If users do not feel these reactions to modern technologies, they will discard them.

My research suggests that while innovative and original technologies can be momentous, they can only create a temporary space where users notice a new technology but still experiment with whether it will add any new value to their lives. It is that space where designers can focus on communicating the story, narrative, or explanation of how their design will enter people's lives and become part of it. In that space, users decide if they will invest enough time to adapt and co-exist with that novel technology. If state-of-the-art technology lacks depth or value, users might try but soon disregard that technology as it takes time, effort, commitment, self-discipline, and money to establish a new co-existence. If the experience is only a novelty, they would simply ignore it.

The findings suggest that designers could explore ways to apply novelty to support and encourage faster or easier adaptability in early interactions. The notion that emerging technologies and smart products cause addiction or might make humans too reliant on technology is a significant factor for designers to consider. However, these concerns could be investigated after long-term interactions when the technology has reached the centre of users' lives and they have accepted it for its functionality.

During the early interaction phase, technology is still moving closer to the core of people's lives. Once the technology reaches the centre of peoples' lives, designers may need to move towards giving users more control and avoid intervening in the interaction. They could offer various options and modes of interaction and provide further information on the interactions. For example, a smartwatch is a technology that is already close to reaching the core of some people's lives as people are using it more every day (Cipriano et al., 2021). The flexible UI (User Interface) designs and styles of a smartwatch enable it to fit into various users' lifestyles, track users' health, manage their communication, or act as an E-wallet. Yet, it has still not been heavily immersed in users' lives. For example, historically, watches have had strong sentimental values as they were so close to a person's identity and sometimes passed down to the next generation. However, smartwatches are yet to meet such a level of emotional involvement. Therefore, as designers, we can shape and design the experience of such devices before they move to the centre of people's human lives.

Lastly, Ames (2015) argues that users have different ideologies. They view and prioritise technologies differently. Charismatic technologies have long influenced and positively impacted user experiences, even when they did not deliver what they promised. Comparably, some participants were more accepting of Vector due to its charisma, presence, and personality. They identified some of Vector's limitations, but they forgave those limitations as Vector's charisma played a stronger role for them.

5.1.5. Negotiating the interaction

One of the coevolution outputs participants were concerned with was the human reliance on technology. Their trepidations raise the question that perhaps people are relying too much on technology. Daily human life experiences, how we co-exist and co-operate with technology, have been shaped so that more tasks, whether menial or specialised, are allocated to technology. Such reflections indicate a sense of lacking agency for users in the coevolution of humans and technology. Humans desire to feel acknowledged and be in charge (Flett, 2018). My research suggests that users need to be involved with how and when technology can take over. The design needs to have a clear explanation of what goes on behind the scenes. My findings suggest co-creating with users could enhance clarity and clear design communication that fits well with the users' lives and can enhance their sense of having control over the course of events.

If users consider a particular technology is intrusive or makes people lazy, it will likely affect their interaction with that technology. My findings suggested that participants' views on their memories and past experiences and their familiarity with technology could influence their judgment on the outcome of a new interaction. For example, most participants had some knowledge and familiarity with Alexa. Due to raised concerns around privacy issues relating to Alexa's use in different media, they were not enthusiastic about trying the Alexa option embedded in Vector. Another example was that some participants were concerned about the level of content and information they were receiving. They noted that they continuously act as a filter to ensure only important and meaningful information reaches them. Those participants found themselves having a higher workload than before using smart technologies and, at times, feeling overwhelmed, finding such technologies to be intrusive. Thus, my data suggests that designers need to consider such perceptions in each design iteration, which is a continuous process.

Throughout the data collection and analysis, I observed ageing users having a positive bias toward data security and privacy management in emerging technologies. It seemed that with users either being retired or leading to retirement, they have fewer concerns about the breach of privacy influencing their socio-cultural context. Their view on the use of technology was that users need to compromise to benefit from all of what technology offers them, including giving up some aspects of their privacy. They saw their interaction as a form of negotiation – their interactions came at a cost and were not one-sided relationships with them benefiting all the time.

While the ageing users might perceive their interaction as a form of negotiation, there were situations where participants were not willing to sacrifice their data privacy or sensory elements. It seems that for active ageing users, some topics and concerns are more vital than others. For some areas of concern, participants were not concerned at all, while for others, they were not willing to negotiate or compromise. This scenario can be seen not as a contradiction but as ageing users' prioritising their needs. It is important to identify what matters the most for ageing users, what they get out of the negotiation with emerging technologies, what they are willing to see as negotiation as they will get something out of that interaction, and what they are unwilling to sacrifice.

For example, some participants' comparisons of reading e-books with physical books presented the pros and cons of each experience. Reading e-books can save paper by having thousands of books available on an e-reader tablet. Without needing too much physical space to store e-books, they can easily be carried around at all times. However, the sentimental and visual aspects of having physical books around the house or office or the physical experience of being in a library were desired by participants. With physical books, people enjoyed the experience of seeing the pages and the cover design. The sensory experiences of turning each page, smelling and touching the paper were significant parts of the interaction. People feel the weight of the book they read. In libraries, also, people interact with each other. All these experiences contribute to the user experience of reading a physical book. Participants expressed they were willing only to give away parts of these sensory experiences and not all of them.

Perhaps, they might be willing to give up the social aspect of someone shushing them in a library but not the sensory element of seeing a book.

When designing for any given age, it is crucial to understand users, their context and lived experiences. Depending on the stage of users' lives, they might be willing to negotiate different things. It is valuable to recognise distinct priorities and sacrifices of varying target users, to understand what and how much they are willing to negotiate, give up, and what benefits they are seeking in return. For example, knowing they sacrificed their privacy for certain companies to collect data in return for receiving free services was accepted by most participants. Although participants did not mind giving up their privacy, they acknowledged it is unlikely to be the same case for younger generations. In fact, the data indicated that participants were concerned about the impact of intrusive technologies on younger users and the type of lives they will lead as a result.

5.2. Implications for design

Several lessons for designers can be drawn from the contributions of my research approach and the findings. The results provide insights gathered from the field data that can enhance and improve the design of social robots. The five following topics explore the design implications of the study's insights.

5.2.1. Design for emotions, not measuring emotions

My research findings suggest that to design better future smart products, it is not enough to only consider the assessment of emotions in conventional design approaches that emphasise users' ratings, such as the works of Chitturi (2009) and Desmet (2012). Emotions and feelings are subjective human experiences (LeDoux & Hofmann, 2018). The complex nature of users' experiences and emotions requires consideration of the various aspects of technologies beyond their physical influences. Therefore, objectively or empirically measuring users' emotional responses and designing for emotions could lead to several risks and shortcomings in delivering a meaningful experience.

Vector was designed to have very emotional expressions. While such expressions were effective for some participants, for others, they were perceived as annoying, creepy, or not genuine. Users' social and subjective experiences, such as the influence of people around users, and their individual and personality differences, could impact how they perceive and interact with technology. Investigating users' context and lived experiences on their relationship with technology could help designers understand and design meaningful experiences for diverse users' needs, personalities, and preferences.

Implementing human-technology relationship theories in this study enabled exploration beyond usability and functionality aspects of emerging technologies. Participants' reflections on the feelings involved in their interactions allowed me to empathise with their experiences and worldviews. Hence, designers need to consider empathising with users and their worldviews to recognise their needs. To understand users' tacit knowledge, such as emotions (Johnson et al., 2019), designers can conduct contextual inquiries in user research, conducting research beyond labs to immerse, observe, and understand users' experiences early in the research phase of their design practices.

Users' emotions can link to Maslow's hierarchy of human needs (1943), self-actualisation category, and Jordan's hierarchy of users' needs (1998), emotional benefits of products category, as presented in Chapter 2 (**Error! Reference source not found.**). These are b oth on the highest level of the hierarchies, highlighting the significance of emotions in users' experiences and daily lives. Users' emotions are influenced by two categories of 'social influence' and 'hedonic motivations' of UTAUT theory (Blut et al., 2022). UTAUT theory defines social influence as users' feelings associated with using a technology based on the social context. UTAUT highlights the positive feelings associated with using technology as hedonic motivations, which is considered essential in determining technology adoption. Furthermore, the MCLM model (Chen et al., 2016) considers subject measurement approaches, such as self-report, best suited for understanding users' perceptions.

5.2.2. The construction of human-product

The research findings surprised me since participants seemed very knowledgeable and reflective of their lived experiences with technologies. They also clearly have been through some of the most disruptive technological changes in the last few decades, reflected in how they talked about their experiences. They had significant experience in various modes of technology, from mechanical types of machinery to the first generation of computers and are now using smart products embedded in their homes and offices.

It is also important to mention that even in such a small group of participants, the range of experiences and opinions was more than what research on ageing users often illustrates. In their systematic review of the involvement of older users in research and design practices, Fischer et al. (2020) identified that 90% of the studies portrayed ageing users in a deficit view, such as technological illiteracy. I anticipate that it is quite likely that other designers may similarly under-appreciate the level of self-reflection, the range of experiences, and the diversity of views in ageing populations. Hence, my research indicates that designers need to consider the diversity of this target population. When designing for active ageing users, techniques such as Personas may be somewhat limited in identifying the diversity of the ageing users' needs and experiences. Co-designing with users (Sanders & Stappers, 2008) is a sound research and design approach to include and engage users as the experts in the centre of all design activities and processes.

The findings highlight the importance of designers stepping away from the 'expert' mindset. Designers can embrace and drive inclusive research and design practices by situating themselves in users' lived experiences and empathising with them beyond an expert mindset and solution-oriented view. If designers play the role of facilitators, users can then engage and lead research and design practices by reflecting on their lived experiences, sharing their needs, providing views, ideating, and developing their desired future. Using generative tools (Sanders & Stappers, 2012) could be one way of engaging users in the research and design process.

Design practices need to consider going beyond the human-centred approach to include the objects' agencies and their influence on the user experience. When exploring and conducting user research and design ethnography, it could be useful for designers to consider the 'AEIOU' mnemonic (activities, environments, interactions, objects, and users) in their research and design practices (Hanington & Martin, 2019). For designers seeking to create design solutions from an inclusivity point of view, it is not sufficient to only contemplate usability and functionality. The introduction of inclusivity is a catalyst for constructing a new social and emotional space—the interaction of human-object debates the current understanding of inclusive design practices.

Considering Jordan product's benefits categorisation (2002), which are practical, hedonic and emotional, design practices need to consider the trade-off and the negative aspects that are being introduced to users when it comes to products. Similarly, such consideration can be argued for the consequences of products introduced by Hassenzahl (2003); beyond the positive consequences, whether satisfaction, pleasure, or appeal, we need to unpack and highlight users' concerns and issues to help them make well-informed decisions.

UTAUT (Blut et al., 2022) recognises the consequences of human-object interaction as the 'facilitating conditions' that inform users' decisions about a given technology. These conditions include the context and the infrastructure required to use technology. However, since users and technology are coevolving together, we need to focus beyond the user and study user and technology collectively. Similarly, considering users' 'behavioural intentions' can help designers better understand users' reflections and thinking processes when interacting with technology. It is also essential to consider the influence of technology on the users' context and decision-making.

Co-design sessions can be supported with a secondary data collection technique of MCLM (Chen et al., 2016), such as conducting physiological and behavioural measurements. Secondary data can assist designers in better unpacking the influence of technology on users' reasoning and thinking process through monitoring their behaviour and physiological responses.

Technology is not simply a tool to use and disregard afterwards without any effects. Technology has its agency and prescribes a particular framework of behaviour towards the users. It can be said that tools use humans as much as humans are using tools (Latour, 2005; Morton, 2013). In the present study, I used the epistemological view of social construction for design research of human-object interaction. That included literature beyond usability and brought in ideas from social science practices to explore a bigger context that influenced the user experience.

5.2.3. Designing a presence

The findings suggest that designers might explore new forms of relationships between humans and technology, which is a unique form of 'presence'. In my research, it became evident that some participants formed an affinity to Vector due to its unique character, chirping sound, and physical presence of moving around, not its functionality—even though some participants' discourses were centred around functionality. Vector seemed like a cheerful and exciting companion to some and an annoying toy for others. Due to the significant differences between users, how they reflect, and their experiences with smart products, I recommend it is highly crucial that designers not assume that they know what 'companionship' means for users or that it is a universal notion. Such insights are unlikely to come from just talking to users. To reflect on what companionship means, users need to go through extended interaction with prototypes. It was only through this approach that my participants were able to reflect on their experience of interacting with Vector and imagining their desired future interactions and relationship with emerging technologies.

Technology is involved in the everyday lives of humans. People conduct many of their tasks and activities through digitally mediated platforms. Therefore, when designing an interaction between humans and technology, it could be significant to unpack this experience as a relationship between two parties. Regarding companion robots and what companionship means, it is beneficial to consider how a particular robot's presence can support users in their everyday lives and activities. As highlighted in my research findings, companion technologies could assist users in feeling comfortable exploring other technologies.

The design of a presence as a new form of companion technology can benefit from four theories introduced in the literature. Considering Terninko's product features (1997), the three product types he outlined can bring differential advantages to technology. Designing a companion technology is not only limited to delivering the basic tasks that are expected by users. It is also about considering the exciting features of the technology.

The takeaway from these reflections is that if designers want to create inclusive and meaningful interactions for different generations of users, they need to move beyond simply replacing one form of interaction with another. Participants observed that companion technologies are mainly designed to replicate what humans or pets would offer as companionship. When interacting with Vector, most participants enjoyed its presence as something to be there. Participants defined Vector's presence in its behaviours, such as the chirpings sounds and its mobile and explorative characteristics. Except for Vector's usability and functionality limitations, participants appreciated its distinctive robotic attributes and that it did not look like a specific animal or a human.

To design a pleasurable and exciting experience, Wright et al. (2018) four characteristics of experience could be embedded in the interaction: compositional, sensual, emotional, and spatiotemporal. On the other hand, Norman (2004) brings to attention the importance of users' responses to a given technology by measuring their level of engagement. Similarly, to measure users' responses, the theory of engagement proposed by Chandler and Lusch (2015) can further assist designers in unpacking how a companion technology can appeal to users based on their past, present and future dispositions.

Considering users' responses over an extended interaction to re-evaluate how they respond to a companion technology can help designers measure the performance and long-term influence of the technology. How users interact with a prototype over an extended period can be guided by the MCLM's task performance measurement category (Chen et al., 2016). Combining subjective measurement of the MCLM model with extended user research can provide users' reflections and better unpack their reasoning.

5.2.4. Privacy and sense of agency

With the rise of digital technologies, privacy protection and issues are on the rise, compared to the pre-digital age when communication was mainly done via analogue media such as letters or the telephone. Hence, designers need to explore at the forefront of their designs how much control and agency they provide to users. My research focused on how human agency is exercised in human-technology interactions. The research findings urge designers and researchers to distinguish between the two meanings of data privacy and security. One is the control and agency designers provide to users through their design. The second one is the setting and the way captured data from users will be stored and used through interaction with a technological system. When designing for human agency, Brakus et al. (2009) considered four dimensions that influence users' experience, including the semantic and symbolic values of a design, enhancing the users' sense of agency.

The trade-off between benefiting from free information and software and giving up personal data was initially acceptable in principle by most participants. They felt safe with the companies protecting their accounts from hackers and did not mind companies using their personal information, as almost all participants suggested they had nothing to hide. However, most participants felt quite strong regarding protecting their sense of agency when interacting with smart technologies. Some participants found automatic updates on computers and smartphones annoying and, in the case of Vector, even rude. They also raised the issues of human agency when they observed Vector watching them or waking up without command.

With machine learning in AI systems relying on a vast amount of data for pattern recognition, there is often a trade-off between privacy, rights to data, and the technical quality of the product, which can influence privacy-violating practices (Zwitter, 2014; Herschel & Miori, 2017; Lipworth et al., 2017). Businesses and companies now have increased the ability to invade privacy and manipulate information for corporate gain (Müller, 2020). Therefore, the designer's role in AI ethics is to explore how they could make the operational systems more transparent, informative and in a form that would respect users' sense of agency. Using techniques such as card sorting can enable designers to comprehend how participants rationalise, sort, and relate different elements of privacy and a sense of agency together (Hanington & Martin, 2019).

Participatory design practices (Muller, 2007) can assist designers in identifying terminologies that are vague or have several meanings associated with them, such as the issues around privacy. Involving users in generative and evaluative activities such as card sorting can assist them in having the ability to make educated decisions about data privacy. Users need to know where and how their captured data will be used. Like participatory practices, the framework of Pucillo and Cascini (2014) proposes the opportunity to involve users' interpretations of objects in design decisions.

Suggested by three categories of consideration in UTAUT (Blut et al., 2022): Performance and Effort expectancies, and Facilitating Conditions provided the opportunity to study users' expectations about technology offerings, usability, and the context and conditions that influence users' decisions and views on privacy and agency. Understanding users' knowledge and their perception of data security and privacy can be made possible by combining usability, self-reflection, and user behavioural measurement categorised in MCLM

(Chen et al., 2016) as task performance, subjective measurement, and behavioural measurement.

5.2.5. Regulating design intentions

Through conducting an extended multimodal user research, I observed that participants felt diverse emotions toward Vector at various stages of interaction. Therefore, it is important for designers to acknowledge that users might have various experiences with a particular technology at different points in time. My research indicated at least three stages of interaction with smart products for designers to pay attention to - first contact, extended interaction, and long-term use. Similarly, the three types of interactions and their influences on users' emotions proposed by Desmet and Hekkert (2007) can inform designers to identify and prioritise their design intentions for different stages of user experience. For example, while aesthetics can be more pronounced in early interactions, the value, meaning, and emotions associated with technology can be a more dominant factor in the long-term interaction.

During first-time interactions, feelings such as excitement, uncertainty and unfamiliarity could be explored. Designers could focus on creating a welcoming sense, trust, and confidence for users at this stage of interaction. After an extended user experience, while users are building an understanding and a sense of familiarity with technology, the focus could shift around usability. It is only after a long-term interaction that users experience the more significant impacts of the technology on social and contextual factors. This stage is where users often explore the positive and negative effects of technology. At this stage of interaction, designers could again regulate their intentions and research the meaning of the specific technology at hand for users. Potential techniques such as journey mapping and storyboarding by users interacting with a prototype can help designers to monitor and purposefully design diverse types of interactions. Users' subjective assessment of the technology can be measured through journaling. Their behavioural and task performance can be measured through observation methods. Approaches such as conducting interviews at different points of interaction and observations could support drawing a realistic map of the user experience.

The process of regulating design intentions could be a critical factor to consider when designing future technologies which are meaningful and inclusive. With positive or negative aspects of technology, users require a transitional space to explore both aspects. My study shows that to design more creative, pleasurable, and inclusive experiences for ageing users, designers need to constantly monitor and regulate the impact of such technologies even where users may benefit from the advantages and strengths of new technologies.

As stated throughout the thesis, a shift from design research solely focused on investigating the intended technological aspects of design to one that investigates users' lived experiences can provide nuance opportunities for future design practices. The human-technology relationship is not just a positive or negative experience to rate; there are many experiences in between the spectrum to explore, improve, and design. For example, the participants in my study did not focus only on technology being good or bad, but on how they will be used and in what context. Hence, users' attitudes may not be a simple matter of being against or for technology, but rather selecting what kind of technologies they want to interact with and in what ways.

Similarly, the social influence of using a technology proposed in the UTAUT framework (Blut et al., 2022) is more dominant before interaction and at the purchasing stage. Social influence is when users' decisions are informed by people around them and the surrounding stimulus. Therefore, designers' understanding of social influence can help them create a novel design by addressing and understanding the surrounding stimulus that influences users' decisions. The hedonic motivations category of UTAUT theory can be more significant in the after-purchase and early interaction stages. Only after long-term interaction will users assess the use of technology and form their final decision about it.

Designers need to identify the intention of the design that they want to deliver. Pinpointing where the technology is sitting in users' lives can assist designers in formulating their design intention. If they realise the technology they are creating is already perceived as undesirable by users, then the potential focus could be on reshaping and repurposing the experience. At an early stage of interaction with a particular technology, the concern can be about setting boundaries or designing a sense of agency for the users. Designers could even explore adding some boundaries to how much technology can be introduced to users or focus on ways to facilitate user adaptability. Overall, the findings suggest that designers need to regulate their design intentions continuously.

To generate inclusive and meaningful design solutions, there is a need to engage designers from the early stages of education in practices that consider the complexity of user experience. To respond to this call, together with the supervision team, we proposed a pedagogical model to address the multidimensional aspects of users' emotional experiences (Moradi et al., 2019). Our paper stated that the complex nature of the interaction between smart products and users requires in-depth studies to investigate beyond the parameters of laboratory contexts and focus on educating young designers on how to design for users' emotional experiences and not just measure their emotions. The designer needs to practice investigating users' emotions by analysing physiological, gestural, behavioural and verbal responses and analysing the social and contextual aspects that influence the experience. Studying all these dimensions of users' emotions provides insights for an in-depth understanding of the interactive experiences of ageing users with smart products.

Based on my research findings, I elaborate that design for the ageing population needs to be respectful and empowering. Designing for empowerment is about creating responsive technologies which support a sense of agency and do not interrupt users' main reasons for interacting with the given technology in the first place. For example, participants noted that they wanted to limit automatic modifications that commonly disrupt their user experience. Reflecting on the literature and my findings, I recommend that design needs to emphasise constructing responsible technologies and smart products with respect and trust for users at heart.

5.3.Summary

In this chapter, I presented the key findings of my research and their implications for design practices. I first expanded upon important information captured from data that brings forward the complexity of the emotions involved in ageing users' interaction with emerging technologies. Furthermore, the key findings illustrate ageing users as knowledgeable and experienced users with diverse needs and expectations.

Another significant topic discussed was participants' concerns with companion technologies designed to replicate human and pet behaviour, characteristics, and relationships. While participants sought technologies that present natural and organic behaviours, they wanted to have the ability to differentiate between machines and living beings to avoid getting involved in an illusion and being deceived. The findings also indicate that companion technologies designed for loneliness can be designed around creating a presence.

The data also identified that, for most participants, privacy was a trade-off for free information and software. Most participants were aware of issues raised by a lack of data security and user privacy. However, they felt comfortable based on the context of living. They were more concerned with a lack of agency and control with automation and machine learning.

Lastly, an important insight from the data signifies the importance of creating different experiences for various stages of an interaction. The results suggest that with participants feeling different emotions at various times of interaction, from first-time interaction to long-term use, there is a range of needs and expectations to be met. To conclude, the findings presented in this chapter urge designers to step away from the expert mindset and to practice inclusive co-design and co-research practices.

CHAPTER 6. CONCLUSION

"And once the storm is over, you won't remember how you made it through, how you managed to survive. You won't even be sure whether the storm is really over. But one thing is certain. When you come out of the storm, you won't be the same person who walked in. That's what this storm's all about."

- Haruki Murakami *(Kafka on the Shore,* 2006*)*

This concluding chapter is an overview of the outcomes of the present research and its contribution to knowledge. I present the findings in relation to the research question and examine how this study has contributed to original knowledge production, both in terms of the methodology and the findings. I discuss the advantages of extended user research as a methodological approach and the main research contributions of active ageing users, their coevolution with emerging technologies, and the design of companion technologies beyond mimicking characteristics of existing relationships with living organisms and beings like humans and pets. I then present the potential implications of the findings to design research and practices. To conclude, I discuss the research limitations and propose an agenda for future research.

6.1. Addressing the research questions

Throughout this research, my thinking was directed by different philosophical and technological territories beyond design practices. The main objective of my research was to present an exploratory study to understand ageing users' emotions concerning emerging technologies. I aimed to answer the research questions listed below.

> ***RQ:*** What are the emotional experiences of active ageing users interacting with social robots?

Following the philosophical stance of social constructionism (Burr, 2015), the present research sought to explore the emotional experience of active ageing users interacting with social robots, which contributes to design and technology. Informed by the literature's definition of emotions and how they are formed (Barrett et al., 2019), I took a different approach to understand active ageing users' emotions in my research. Instead of measuring emotions, I considered participants' reflections and thoughts about smart products, social robots, and their interactions with Vector to understand their emotional experiences. I hoped exploring this assemblage from an empathic lens would explain a feasible opportunity for designers to refine and inform the design of future technologies by examining what constitutes meaningful and emotional experiences for active ageing users that could inform their designs.

In Chapter 4, Theme 1 presented the perceptions and emotional experiences of active ageing users toward technology in detail. Participants were fascinated and wary of emerging technologies such as social robots. Theme 2 explained that active ageing users viewed emerging technologies as coevolutionary interactions that are not either positive or negative. Participants reflected that humans and technology both influence each other and coevolve together. Lastly, Theme 5 captured participants' emotional experiences and reflections on companionship and social robots and the boundaries needed to place around them.

In Chapter 5, the boundaries of human and technology coevolution, the social and emotional trajectory of ageing with technology and artificial companionship illustrated key considerations about social and companion robots being researched and designed to replace the organic and living companionship people have with each other and animals. It highlighted participants' values and needs around ethical approaches to the design of future technologies. I recommended implications such as designing a presence and practices that consider users' emotions and lived experiences instead of measuring emotions. These topics discuss the urge to design a new form of companionship that supports and fits into active ageing users' lives. Such designs could enhance existing organic relationships instead of mimicking or replacing them.

> ***SRQ1:*** What are the experiences, challenges, and issues of active ageing users when introduced to a new smart product?

The extended user research provided the opportunity to identify the diversity and temporality of users' experiences at different stages of interaction. The result indicated that novel experiences engaged participants in the early interactions to explore and interact with the new smart product. However, during the extended interaction, they paid more critical attention to the values and offerings that the product might bring to their lives. Participants found that the product's novelty started to fade or feel toy-like.

Reflecting on the study with a relatively small group of participants, I noted various experiences and challenges that are influenced by active ageing users' personalities and social factors. The main consistent view shared among participants was that technology, whether challenging or inspiring, is part of contemporary human lives and that the negotiation between the human 'use behaviour' and 'technological offerings' influences human lives and technology.

This perception challenges the notion of technology as an external problem-solving innovation emanating from outside of ageing users' lives to be injected into them.

Topics such as feeling forgotten highlighted the rhetoric effects of age-related stereotypes on active ageing users' shopping, adoption, and learning experiences concerning technology. While some participants expressed low confidence in adapting to new technologies, they learned how to interact with Vector effortlessly. Overall, the results of the extended user experience demonstrated active ageing users as eager and quick to learn how to interact with new technologies such as social robots and interested in catching up with technological advancements.

The findings identified that design practices need to move beyond the stereotypical view of age-related activities that emphasise technologies that support the increasing frailty that comes with old age. The research highlights a lack of reflective studies focusing on active ageing users' perspectives of what constitutes meaningful and emotional interaction in the current digital era. The present study shows active ageing users are interested in learning and interacting with new technologies. They presented high critical reflection and thinking about how technologies such as social robots could influence their lives and relationships.

SRQ2: How may active ageing users interact with social robots?

Theme 3 described the interactivity of new technology, such as a social robot, and how it influences active ageing users' experiences differently in engaging or disengaging with it. It illustrated that the design of a social robot needs to consider a balanced level of learnability, playfulness, novelty, tangible experience, familiarity, and responsivity to deliver a meaningful and usable experience for the diversity of active ageing users and their needs. While a social robot such as Vector presented a novel experience in the early interactions for all participants, most participants desired more offerings from the robot by the end of the extended user experience. Such results highlight the significant influence of interactive elements such as novelty in early interaction and adaptation stages but less important as factors such as usability and usefulness that are important for long-term use.

One other noticeable finding was that participants' emotions toward Vector were influenced by their social circles and those people's reactions toward it. When participants' friends and family were interested or curious about Vector, participants seemed to have a more positive experience and interaction with Vector. Similarly, when their social circles responded negatively toward Vector, participants commented that they experienced negative emotions about interacting with Vector. The finding portrayed the impact of social context on how active ageing users may interact with social robots and that design for active ageing users should consider a broader range of users and stakeholders that could influence the overall interaction.

> ***SRQ3:*** What are the benefits of smart products such as social robots for active ageing users?

Some conversations highlighted active ageing users' concerned emotions about constant adaptation to changes and the automated setup and lack of human support during the learning curve. These concerns highlighted the importance of social support and customer services in the early stages of interactions, such as setting up a new product for the first time and the learning stage. Some participants reflected that social and playful robots could be a segue to support and allow users to feel more comfortable with emerging technologies and trying new smart products.

Furthermore, another topic that emerged from the conversations was that technologies like social robots could be designed in a way to support human agency and allow users to have control and flexibility with their use of such technologies. These topics challenged the design of automated technologies that, while aimed at bringing efficiency, can be perceived as removing human independence.

> ***SRQ4:*** How does extended multimodal user research conducted in real-world environments support the study of complex smart products such as social robots?

The research question was addressed by reporting on the participants' experience of interacting with a social robot, using an extended multimodal user that considered MCLM and UTAUT frameworks and theories from the fields of design, HCI, and HRI. The research approach allowed deeper discussions with participants and involved reflections on emotional and lived experiences. Beyond applying interdisciplinary frameworks and theories to unpack active ageing users' relationships with emerging technologies, my research approach challenged the conventional design processes and methods.

The extended multimodal user research approach used in this research allowed me to capture the changes and complexities of users' emotional experiences over time. It provided a multi-dimensional lens toward the experience and considered the social and physical context of use. I did not focus on rating whether a product was suitable, good, or bad, but rather on exploring the events and relationships that influence and shape the users' lived experiences with technology over an extended time. Some participants identified Vector's novelty fading away after a few interactions and looked for more meaningful values and offerings.

The semi-structured interviews with participants before and after the extended experience of interacting with Vector allowed for discussions around human relationships, social values, views on companionship, and whether robots could support or play a role in it. The questions were framed around the lived experiences of active ageing users, starting with their general view of technology, smart products, and services and then moving through conversations about ethics, values, and privacy concerning emerging technologies. The final set of questions was framed around the social aspect of technologies in relation to participants' socio-cultural contexts. The framing of the interview questions allowed participants to reflect on their various lived experiences with different technologies. It provided opportunities for them to reflect on the possibilities and limitations that current technologies present to their lives before reflecting on where smart products could contribute to their lives in future.

6.1.1. Realisation of objectives

The main aim of this research was to present a critical reflection on an empathic inquiry and to provide a clearer understanding of ageing users' interaction with smart products. The obtained information can inform how future products can be designed to be inclusive and meet active ageing users' emotional expectations. The study answered the research question by meeting the following objectives:

1. Study how ageing users interact emotionally with smart products

Two interviews were held with each participant, one before and the other after the extended user experience with Vector. Interviews data were analysed based on participants' reflections on their lived experiences, interaction with Vector, and abductive thinking about future technologies. The findings suggest that active ageing users felt fascinated and wary about emerging technologies. Conducting interviews at two separate times allowed in-depth discussions with participants and created a safe space to share their feelings and concerns. Each interview lasted 1 to 2.5 hours, reflecting on participants' engagement with the topic.

Comparing participants' first-time interactions with Vector with their interactions after two weeks provided detailed, objective data on participants' changing reactions to Vector. Vector's novelty, tactile features, presence, functionality, and purpose influenced participants' emotions differently based on their personalities and characteristics.

2. Investigate the emotional transitioning process users are going through to adapt to new smart technologies

The study encouraged discussion on the influence of emerging technologies on active ageing users through participants reflecting on various life experiences relating to technological advancements. Participants described both positive and negative aspects of diverse emerging technologies in different areas of life that have required people and technology to adapt to each other, revealing that it is not only the users that are adapting to new technologies.

The findings manifested an understanding of the subjective views of ageing users on adaptation as a two-way process that designers need to consider – a coevolutionary process. This insight indicated that ageing users are evolving with technology, and technology is evolving with them. Participants reflected on how their interactions with new technologies not only influenced them but had an impact on the technologies themselves.

3. Demonstrate how to study smart products from an emotional experience viewpoint

Studying social robots from an emotional user experience viewpoint helped to unpack the complex social context of the user-technology relationship that contributes to the overall experience. While the research was informed by different fields such as HRI and HCI, this study of smart products through social robots had a design and exploratory approach. Rather than focusing on short snapshots of users' interactions in a controlled lab environment, my research demonstrated the users' complex social context through long-term interactions and how users' emotional experiences change over time. My research insights were gathered from the 'field data' that can enhance the study of social robots from a designer's point of view and user experience.

The journaling technique allowed users to reflect and capture their experience of interacting with Vector in their home environments over an extended period. The journal allowed the participants to consider the questions that were asked in the first interview compared to the experience of how they felt about Vector during the two weeks. The journaling experience provided an opportunity to explore the contexts that were influencing users' experiences daily. For example, some participants reflected on how their friends and families' comments about Vector influenced the way they felt about it on a particular day.

4. Analyse the results of the study in view of current related literature and design practices

Going through past and current related literature in HCI and design practices, this research shows that there is space to improve when it comes to understanding human-technology interactions and users' emotional experiences. My research points out a step away from the human-centred approach to reconsider objects' agencies and influences on users' experience as well. This consideration was done by comparing and analysing the results of the research in view of current literature and practices.

The research highlighted that much of the UX research in HCI and HRI is done in frameworks that use lab-based studies and shorter periods (Alenljung et al., 2019). A limitation of lab-based studies is that they do not consider the complexity of user-technology interactions and the users' lived experiences. My study applied a design lens to the field of HCI that allowed empathy with active ageing users. It allowed them to reflect on and explore the potential design of future smart products.

5. Discuss the insights from the study to explore ways of creating more pleasurable and inclusive experiences for ageing users while benefiting from the advantages and strengths of new technologies

The insights from the study implicate shifting the research and design focus to the in-between space of human-technology coevolution. Emphasising solely on users or technological aspects could limit the opportunities to investigate and explore practices, interactions, and emotional experiences constructed with and through user-technology interactions and influences on each other. When it comes to social interactions and human-technology negotiations, there are shades of grey and nuances to explore. A coevolutionary lens can provide opportunities for co-researching and co-creating more pleasurable and inclusive design solutions with ageing users to enhance benefiting from the advantages and strengths of new technologies.

Design intentions are important factors to consider when designing future technologies that are meaningful and inclusive. There is a need for transitional space so that users can explore the positive and negative aspects of technology. It is not enough simply to design and deliver a product and expect the adaptation to the product to happen on its own. Regulating design intentions can help designers proactively engage in the user experience. One way to achieve this is to involve participants from the early stages, even in the stage of questioning the philosophical ground of what designers are trying to create.

6.2. Significance and contribution to knowledge

This research has made contributions to knowledge beyond the initial research question. As presented in Figure 6.1, the study contributed to the development of both theoretical research outcomes and methodology. On the left side of the figure, three theoretical contributions are presented that explore the topics of active ageing users, their coevolution with emerging technologies and the exploration of companion technologies that move away from replicating human relationships. The right side of the figure illustrates the three methodological contributions to conventional user research studies - the extended user experience method, research conducted in a natural environment and multimodal research approach.

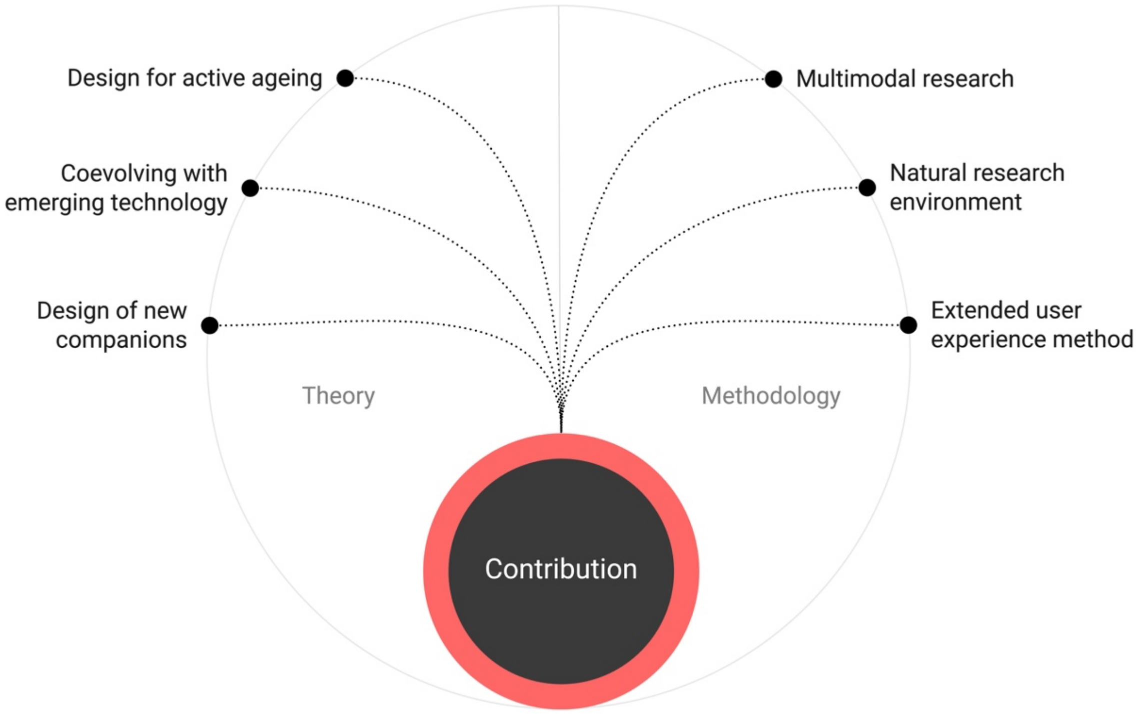

Figure 6.1. Research contributions to theory and methodology

6.2.1. Theoretical contribution

My research has made an original contribution to theory by providing an in-depth understanding of the concept of ageing with technology. Ageing users' experience with emerging technology has been mentioned and explored in the past. Most studies have focused on seniors who are part of bigger social groups such as retirement home residents and not the generation before them, whom I have referred to as active ageing users. I suggest using the term 'ageing', which implies the continuity of growth. The study does not view age as a static concept, such as older adults or old age terminologies used in most literature. It is important to note that my intention and view on the older demographic users from the beginning of this research was based on an active age group who has been experiencing radical changes in technology. However, the term "active ageing users" came from the participants' perspective, reflecting on their worldviews. Similarly, the concept of "emerging" technologies reflects the continuous changes in technology.

Design for active ageing

The perspective on active ageing users described in previous chapters provides a fresh lens on design for older demographics. The active participation of users and continuity of ageing are significant factors to be considered in designing for this area. Most design practices and studies on older demographics primarily address senior users and fall short in identifying and addressing the needs of active and independent ageing users (Oeldorf-Hirsch & Obar, 2019; Baker et al., 2020; Loi & Lodato, 2020).

My study focuses on active ageing participants who live independently and are actively involved in the public through work and social activities. The research differs from the studies such as Broadbent et al. (2012) conducted at a retirement village. My participants did not live in retirement villages that have the support of bigger social groups with caretaking operations. While Broadbent et al. (2012) acknowledge that social robots could provide companionship, their research mainly explores the usability and functionality of a healthcare robot through questionnaires. They do not investigate users' reflections, lived experiences, and explanations for their concerns.

Design and research tend to accentuate demographic-based practices. While demographic classification can reveal important information on general human characteristics and behavioural patterns, it can have the disadvantage of oversimplifying individual differences. For instance, in their research, May et al. (2017) explored the physical attributes of robots. They used surveys to measure participants' level of acceptance. Their results conclude that 'adults' as a unified demographic accept and feel comfortable with robots. However, my research illustrated that it is unreasonable to identify ageing users as a static and unified group.

My initial idea of conducting research with participants aged 65+ turned out insufficient. I recognised that there was a range of different needs within the older generations of users. More specifically, I wanted to understand active ageing users' needs before retirement and post-retirement. As a result, I expanded my targeted demographic to participants aged 50+. This decision allowed me to study participants aged 50 to 65, leading up to retirement, and participants aged 65+, who are in the retirement age. Similarly, the research suggests that different personalities, emotions, and backgrounds also contribute to the experience of active ageing users, and they cannot simply be categorised as one size fits all.

My early assumption was that participants' views of technology might be influenced by gender biases. This assumption was due to the early results of my data collection suggesting that female participants favoured Vector more. However, as my study progressed, the influence of gender on the experience became less relevant. Additionally, research on the impact of users' gender on the experience usually requires extensive research on a more considerable number of demographics, which was not the scope of this research.

My analysis indicated participants' personalities had a prominent influence on their preferences. After the extended interaction with Vector, most participants who presented playful characteristics formed a bond with Vector. On the other hand, people who seemed to appear more serious-minded were expecting more from Vector, and its cheerful design became annoying to them. This finding suggests that participants were split into two categories. One category was more engaged with emotional and playful aspects of technology, and the other category was more focused on its functional aspects. Both groups, however, were expecting more from Vector. The first group wanted Vector to have better and more natural conversational skills. The second group wanted Vector to deliver a unique functionality beyond existing products. Both results urge designers to ensure the personality of the technology they are designing matches the target users' needs and expectations. The results collected from my study indicated that while Vector was marketed for the adult age group[17], it did not appear to meet the older users' needs.

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[17] The Anki company had 2 robots: Cozmo, marketed for 8+ age category and Vector, marketed for 18+ age group. At this point, there are no academic journals published on Vector's marketed demographics. More the information provided about the marketed age group for Vector can be found on the company's website and technology reviews websites: https://techcrunch.com/2018/08/08/vector-is-cozmo-for-grownups/?guccounter=1.

Coevolving with emerging technology

In Chapter 4, I noted that participants viewed technology as part of human lives that adapt and change with them, a coevolutionary process. They shared critical and substantial reflections on the human-technology relationship that could not be defined as a set outcome. Instead, their view suggested a much more complex and fluid process of technology, humans, and the context of their lives influencing each other. Their views challenge the common design approach of technology in HCI and HRI that aims to control human-technology interactions by designing and measuring intended outcomes, purposes, and uses.

Hoffman et al. (2016) evaluated such coevolution by exploring peoples' experience of robots reacting and responding to media. Their research was significant since, instead of exploring the direct interaction between the human and object, they looked at the "side effects" of robots reacting to an external situation. While their study acknowledges such co-experiencing of robots and how people responding to media could shape people's perception of external occurrences, their research did not explore people's responses over time. My research findings bring to attention the importance of moving beyond human-centred design practices highlighted by Hoffman et al. (2016). It is crucial to pay attention not only to the users of the artefacts and their environment but also to the artefacts themselves, which participate in the coevolutionary process of user-technology interaction (Latour, 2005; Morton, 2013).

During the extended interaction with Vector, some of the participants' reactions to Vector's characteristics - its response to sound, automatically waking up, dancing to music, and personality - changed over time. For example, participants shared that they did not mind their smart devices collecting personal data in exchange for the offerings. However, when Vector automatically responded and woke up to their movements through its sensors, standard technology in many everyday products, some participants did not feel comfortable with a technology that had a digital face staring at them as they moved around. Similarly, such changes in participants' responses bring forward the consequences of the intended design without considering the complexity of the human-technology relationship and the context of use.

Ihde (2008) calls such a deterministic design approach the 'designer fallacy'. He argued against the notion of designing the use and intent of a technology that considers objects as neutral and focuses on designers' intention and control. His view aligns with my research findings that present the complexity of users, their context and their relationships with technology. The results illustrate that through co-investigating and co-exploration with users, researchers and designers could better understand and consider such complexities and coevolution of humans and technology. It urges a more critical lens to research and design practices for future technologies rather than only measuring the intended use of a product as a signifier for its success or failure in delivering the desired outcome.

Design of new companions

The research findings presented a critical analysis of companion technologies such as robots. The research contributes to more-than-replicating design practices and research. Participants' perspectives on such technologies bring forward the question of whether human-artefact companionship must be built on basic principles of human companionships, such as between fellow humans and pets. For example, the importance of semantic attributes of such technologies has been explored in the design of PARO, the seal-looking therapeutic robot. While some media overlooked the idea of why PARO was designed as a seal, the authors explained that they created the robot in a shape of a seal to avoid using an animal that is familiar to most people. At the same time, they wanted to reference an easily acceptable animal across many cultures and religions to emphasise the benefits of the effects of animal therapy (Shibata, 2012). Most people's unfamiliarity with a one-week-old harp seal covered in white fur allows them to not compare the robot with the actual seal, which results in easier acceptance. Beyond its look, the tactile, auditory, temperature, and balance sensations of PARO were designed to make the robot soft, cuddly, and warm to elicit positive emotions for the users.

Turkle et al. (2006, p. 348) suggested that robots can be considered neither sentient beings nor artefacts but as "betwixt and in between" kinds. Users acting anthropomorphically towards robots does not essentially mean they believe robots are alive. Sharkey and Wood (2014) claim people with dementia can appreciate interacting with the PARO whilst being aware it is a robot and not a living being. My research demonstrates ageing users' emotional and moral concerns towards companion technologies that mostly mimic the organic interactions established between human-human or humans and pets. Overall, participants' distress was due to either smart products and AI influencing or perhaps even manipulating humans' decisions and relationships or when such products' appearance or forms depict deception.

Müller (2020) argues that humans tend to easily empathise with artefacts similar in appearance to living beings. Such a tendency can mislead humans into ascribing emotional and intellectual significance to robots and machines in ways that are specific to human-human interaction, such as care. The creation of 'care robots' for humans has raised concerns around a de-humanised caring future (Sharkey & Sharkey, 2011; Sparrow, 2016). While significant, such apprehensions bring forward the need to distinguish between the care that a robot offers in performing tasks in a healthcare environment and the other form of caring for patients provided by humans. Coeckelbergh (2016) advises that using robots in such spaces could be problematic and deceptive if they 'pretend' to care, unless the deception is on a basic level, such as PARO, and a sufficiently large utility gain counters it.

Furthermore, research suggests that humans have long had an emotional attachment to artefacts (Nyholm & Frank, 2017; Danaher, 2019). As a result, they can find robot companionship attractive, especially people who find human relationships challenging to maintain. In such cases, a feeling of deception could be sensed since currently available robots do not mean or feel what they say. As Paul, a participant, mentioned, "robots are programmed", and therefore, they are not "real", and they do not have a "soul". Hence, it is "cruel" to present them as a companion.

Discussions on the semantic meanings of companion robots, raised by participants and supported by literature, highlighted the importance of analysing why people seek unique but familiar forms of companionship. It is crucial to investigate ways designers can move beyond simply replicating living beings to design companion robots. After all, most innovative and revolutionary robots such as JIBO and Vector have failed to deliver on their promises. As reflected in this thesis, Vectors' novelty, tactile features, presence, functionality and purpose can influence users' emotions. In the case of the entertainment dog robot, AIBO, which had more than 20 years of research and was re-launched, the robot still managed to only find its place in a very small number of people's lives. Banks et al. (2008) conducted research using both AIBO and actual dogs in therapy at a long-term care facility to reduce the sense of isolation among residents. While residents became attached to AIBO, it still did not reduce their sense of isolation. These studies provide a significant opportunity to investigate whether the semantic comparison between real and robotic dogs could impact users' experiences.

6.2.2. Methodological contribution

Arguably, the most significant contribution of my research was the extended multimodal user research which unfolded a more nuanced insight on 'Ageing with Technology'. Employing an extended multimodal user research approach in my thesis was an attempt to move beyond the traditional usability tests and explore the social construct of technology for the active ageing generation of users. The findings and discussions presented in previous chapters demonstrated several advantages of the methods used over the existing techniques in the field.

Extended user experience method

In the context of the methodological contribution, a strength of this study was the extended mode of research that provided significant insights beyond lab-based User Experience (UX) tests. However, my study went beyond capturing a snapshot of user interactions by conducting an in-depth inquiry into participants' prolonged experiences.

I found the two-week timeframe offered participants a chance to reflect, narrate and record additional ideas and concepts about the limitations and offerings of Vector, current smart products and what their future designs could be. I observed participants' first-time interaction with Vector and their behavioural changes by having it at home with them for two weeks. The post-interaction interviews enabled me to gather participants' emerging constructs and observe the changes in their interaction with Vector over an extended period. The results indicated that participants' perceptions of a robot could substantially change over time. After interacting with Vector for two weeks, some participants formed a strong bond with it. Some of the other participants felt uncomfortable with Vector's presence and autonomy, and some felt bored or irritated by it. Furthermore, my research indicates that, rather than age, culture, and other demographic differences, users' personalities seem to be the more significant point in user experience and acceptance of companion robots.

Natural research environment

By conducting the research in participants' homes, I documented and observed their interaction in a more natural environment. In doing so, I collected participants' rhetoric and physical responses. The study demonstrated how conducting research outside a laboratory environment and in a place familiar to users could open spaces for in-depth discussions between the researcher and participants beyond the usability of the technology. Furthermore, researching over an extended period captured the lived experience of the participants and brought forward inquiries about the ethical and moral matters around human-technology interactions.

Research conducted in a controlled lab environment, such as the work of Johanson et al. (2019) around healthcare interaction, primarily measures users' immediate and spontaneous responses based on the simulated experience. Thus, users' responses are commonly measured through physiological and other quantifiable measurements that can benefit first-time interaction studies. Research on healthcare interaction in a controlled environment can be significant and often necessary to ensure the safety of the design before testing. However, it may overlook other factors such as participants' social interactions, attitudes, physical environments, lived experiences, and subjective reflections. It is important to state that my research is not opposing research in controlled lab environments. It argues that the complexity of open and natural environments, such as users' homes and social context, needs to be considered in the design and research practices.

Throughout the study, I applied design theories on emotional experiences to my practices. However, I did not necessarily focus on measuring or rating participants' emotions toward different technologies in a quantifiable matter. I used the theory as a lens for unpacking the complexity of the users' experience and creating a place for exploring lived experiences through the various reflections that participants shared. I was able to identify active ageing users' feelings and emotional interactions with emerging technologies through two rounds of interviews with each participant. The findings suggest that participants felt fascinated and wary about emerging technologies.

The link between active ageing users and emerging technologies is a complex matter. I tried to tackle their relationship in this research from a few different points of entry: literature, multimodal data collection, and a reflective thematic data analysis. The research approach provided a detailed understanding of how the ageing users view their relationship with the emerging technologies by presenting participants' reflections on their past experiences, interaction with Vector, and abductive thinking about future technologies. It offered an in-depth method for identifying the common themes that form the presented concepts of this thesis.

Multimodal research

Another significance of my research was the multimodal method, which enriched my findings. The two-week extended user experience combined with interviews and observational data was an original contribution to UX methods of understanding users. In their research, Hyde et al. (2015) measured users' emotional ratings and physiological responses. While their findings provide valuable information on interactive systems used for therapy and social counselling, they did not investigate users' reflections and the broader discussions around the topic.

Through conducting multimodal user research, I discovered that using physiological data, such as monitoring users' heart rates as a single method of data collection, is insufficient. However, they could be used as supportive measures to validate other data sources for unpacking users' emotional experiences. Similarly, participants shared the contents of their journals in the post-interaction interviews. The journals provided an opportunity and means of expression for participants to capture their daily interactions with Vector and reflect on their thoughts and emotions regularly. They enabled participants to review their journals in post-interaction interviews and share in-depth information about their two-week extended user experience. Subsequently, I would recommend the inclusion of journals in future extended user experience research.

6.3. Research limitations

The complex nature of researching ageing with technology has resulted in specific research limitations. This study was based in New Zealand with a particular focus on an active ageing population. The findings and conclusions I have reached in this research are the product of my attempt to blend social science and technology studies with design methods in the diverse setting of New Zealand. These research outcomes may not be generalisable to other demographics, and the results do not necessarily apply to different contexts. Instead, they are recommendations for designers to consider, engage, critique, and perhaps use to reshape and reconsider their perceptions of ageing users and their design practices in this domain.

The second limitation relates to the methodology. Being a designer, I am trained to look for pragmatic approaches when conducting research. This research was my first effort to engage with an inquiry through the social science lens of discovery. I have been responsible for using a critical lens to look for solutions and solve problems rather than investigating how reality is assembled. I also tended to highlight the role of objects and the non-human in the social construction of the human-technology interaction while perhaps missing the human societal and psychological impacts on shaping user experience. Nonetheless, my desire to investigate the social construction of objects and users has led me to engage more with philosophies and theories such as those of Timothy Morton (2013) and Bruno Latour (2005). Attempts to use such stances in design practices and applied research are very new, and there is not enough literature on how to apply them in design practices.

The next constraint of the study relates to aspects of the data collection approach. I aimed to investigate the complex nature of human-technology interaction by applying various multimodal methods. One of the modes was to collect participants' physiological responses by measuring their heart rates. Collecting participants' heart rates failed to provide a definitive answer in my research. Through multimodal user research, my observations concluded that many other factors besides Vector could have increased participants' heart rates, such as moving around the house to plugging in the robot or unboxing it. Without analysing participants' body gestures, reflections, and thoughts they shared at the time, it would have been invalid to include the heart rate results in the study. Therefore, I conclude that physiological data alone is not the most suitable data collection method for user research studies. There is always the potential to use it as supportive data. I also suggest physiological data are best suited for the lab and controlled environments with controlled variables.

Similarly, the journaling method for capturing participants' behaviour tendencies seemed to be an additional data source but was not vital. There was not necessarily any new information in participants' journals to be analysed. Most of the participants discussed their experience of interacting with Vector in the post-interaction. I should point out that journals were best used as prompts and reminders for the participants to reflect daily on their interaction with Vector and capture their feelings during the extended user experience. Future studies could test if it is of value for participants to keep the journals. By keeping journals, participants might feel more relaxed about reflecting on their experiences, knowing the researcher will not analyse their journals. Referring to their journals, participants can decide what information they would like to share in the post-interaction interviews.

Lastly, I intended to test the research's findings by conducting co-design sessions. An unanticipated obstacle to running the sessions was COVID-19. Due to the vulnerability of the older demographics to the virus and my PhD's timeline, I decided to postpone the co-design sessions for future studies. However, it was interesting that participants used substantial abductive thinking (Kolko, 2010) in the post-interaction interviews. Abductive thinking refers to discussing future scenarios and possible solutions using phrases like 'what if'. In that sense, participants were sharing their ideas and solutions during the two-week extended user experience. They had time to reflect on the unique aspects and limitations of Vector, compare different smart products, and explore the potential of what future products could be.

Despite these limitations, the findings of this study were sufficiently valid and comprehensive to answer my research questions. The study enabled the use of design aspects that were innovative yet familiar and utilised users' past and lived experiences to understand and construct what meaningful and inclusive experiences are for ageing users. The outcomes extended user research methods (Schumacher, 2009) by delivering an applicable social study of users' emotions with practical applications for the field of product design.

6.4. Future research

This research has developed an understanding of ageing and its relationship with emerging technologies such as social robots that could be extended into additional research. Several research opportunities arise from this thesis' findings.

a) What is the role of social context on the changes in active ageing users' emotional experiences?

In Chapter 4, I highlighted that the participants demonstrated varying levels of engagement and emotions toward having social robots in their lives and home environments. Some of the participants even demonstrated different emotions at different stages of interaction. The result illustrated the complexity and variety of emotions based on individual differences, lived experiences, and contextual factors, which aligns with research in neuroscience that emotions are created from past experiences to predict and create current experiences (Barrett, 2017). There is an opportunity for conducting phenomenological research (Byrne, 2001) to further investigate active ageing users' lived experiences, individual differences and their diverse social and physical contexts through different stages of their lives that were beyond the scope of this study. It provides the chance for research and design practices to better understand how such diversities are constructed without presuppositions.

b) How would the coevolution of humans and technology inform inclusive design practices of future smart products?

The second interesting opportunity is to investigate and analyse how these understandings can be applied in design practices and co-create future technologies that are meaningful and emotionally inclusive for ageing users. My research engaged ageing users to reflect and share their lived experiences and the complexity and variety of settings that would influence their relationship with emerging technologies. A further aspect of this complex relationship can be explored by engaging ageing users in design practices. One way to achieve this could be to conduct co-design sessions between ageing users and designers to co-create and co-ideate the potential future technologies.

c) What is the experience of interacting with smart products in a wider context beyond New Zealand?

I conducted my research within the geographical region of New Zealand. While participants were recruited from several different cultures, they could have come from a relatively homogenous socio-demographics background based in New Zealand. Hence, additional contributions can be made by exploring a broader demographic of users. I suggest that future research can be extended to a larger scale by conducting cross-cultural research. A comparison study in countries with different political and social contexts would provide an interesting representation of how ageing with technology could vary in results based on different contexts.

d) Can extended multimodal user research inform design practices in a wider industry setting?

A promising research direction for future studies is combining the skills and expertise of designers and academics to discover how this research could be practised in private companies and industry settings. Furthermore, I hope that disseminating the work to a broader audience of designers and researchers will build upon the framework and methodologies used in this study. Possible avenues would be to elicit design practices that utilise the methods and findings of the research as a basis to challenge the current assumptions on technology and age and explore the coevolution of ageing with technology to co-create design solutions that fit and support ageing users' lives.

6.5. Concluding note

In this thesis, I have applied a social constructionism view, combined with conceptual elements from theories on user experience and technology adoption, to discuss ageing with technology. I presented an interpretive research practice based on the investigation of active ageing users' interaction with smart products aimed at informing the design practices of future technologies that are emotionally meaningful and inclusive. The study highlighted some aspects of the emotional experiences that influence the interaction between ageing users and emerging technologies. My focus was mainly on the aspects that could be considered profound for active ageing users. The results of this investigation reinforce the claim that the use of extended users research to support and provoke conversations around meaningful and inclusive interactions between active ageing users and emerging technologies is an important area for further research.

The purpose of the present research was to explore the complexity of human-technology interaction. Companion robots were studied as a form of smart product to explore the emotional and social dimension of ageing users' interactions with these technologies. I aimed to create a space that could help design researchers to reflect on practices that move beyond the stereotypical view of older generations' use of technology. These discussions are not presented as set outcomes so much as indications for future research and design practices of smart products and advanced technologies that are inclusive and meaningful. I hope the findings have promoted a deeper understanding of the complexities involved in the human-technology relationship and inclusive design research practices. The results encourage moving beyond the limited view of design for the ageing population that only concentrates on usability and technology literacy.

With my PhD journey ending, one of the most remarkable experiences I take away from this once-in-a-lifetime chance is the opportunity and pleasure of learning and working with the participants who took part in this journey. These last few years have presented me with great experiences, challenges, insights, and increased knowledge into the inclusive design and research practices in the field of technology, science, and design that will remain with me for life.

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APPENDICES

Appendix A. **Considered product domains**

	Smart	IoT	Artificial Intelligence	Communication and social capabilities	Assistive	E-services	Entertainment	Tactile and kinaesthetic
Smartphones	■	■	■	■	■	■	■	
Smart kitchenware such as LG smart refrigerator	■	■	■	■	■	■	■	
Smart homes	■	■	■	■	■	■	■	■
Smart trash cans	■	■	■		■			■
Smart TV with pointing controllers and motions for on/off and navigating menus	■	■	■	■	■	■	■	
Smart juicers and coffee machines	■	■	■		■	■		■
Smartwatches and health monitors	■	■	■	■	■	■	■	
Digital and automated diagnosis	■	■	■		■	■		
Assistive medical devices	■	■	■		■	■		
Virtual assistants	■	■	■	■	■	■	■	
Social robots	■	■	■	■	■	■	■	■
E-bikes and E-scooters	■	■	■		■			■
Digital cameras		■	■		■			
Robot vacuum cleaners	■	■	■		■			■
Machine learning devices such as Nest thermostat	■	■	■	■	■	■	■	
Security access and keyless doors	■	■	■		■			
Automobile dashboard interface and infotainment	■	■	■	■	■	■	■	
Sound systems connecting through Bluetooth, WI-FI, and cloud connection	■	■	■	■		■	■	
Clocks / wakeup lights	■	■	■		■	■	■	
Online radios and music apps	■	■	■	■	■	■	■	
Cloud sharing	■	■		■	■	■		
Social media apps	■	■	■	■		■	■	
Virtual concerts, events, and shows	■	■		■		■	■	
News apps		■	■			■	■	
Video games consoles	■	■	■	■		■	■	
Online game apps on phones and tablets		■	■	■			■	
Online bookings such as parking and appointments		■	■		■	■		
Online security and privacy services		■	■		■	■		
Signing up processes, removing, and editing accounts		■				■		
Cashless payments, E-wallets, payWave, online banking	■	■	■		■	■		
Internet Check-Ins such as hotels and airports		■	■		■	■		
Online mobility services and taxis such as Uber, Ola, JUMP	■	■	■		■	■		
Online food delivery and meal-kit services		■	■		■	■		
Online searching process and using search engines	■	■	■	■	■	■	■	
Online shopping and showrooms		■	■		■	■		
Online collaboration tools		■	■	■	■	■		
Digital notepads		■	■		■	■		

Voice/video recording apps								
Emailing								
Video calls								
Netflix and internet-based memberships for entertainment								
Leap Motion								
AR and mixed reality technologies with 3D gestures								

Appendix B. **Ethics approval letter**

Auckland University of Technology Ethics Committee (AUTEC)

Auckland University of Technology
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E: ethics@aut.ac.nz
www.aut.ac.nz/researchethics

15 October 2019

Amabel Hunting
Faculty of Design and Creative Technologies

Dear Amabel

Re: Ethics Application: **19/57 Ageing with technology: A study of emotional interactions with smart products**

Thank you for your request for approval of amendments to your ethics application.

The minor amendments to the inclusion criteria (change to age eligibility and to those living alone) is approved.

I remind you of the **Standard Conditions of Approval**.

1. The research is to be undertaken in accordance with the Auckland University of Technology Code of Conduct for Research and as approved by AUTEC in this application.
2. A progress report is due annually on the anniversary of the approval date, using the EA2 form.
3. A final report is due at the expiration of the approval period, or, upon completion of project, using the EA3 form.
4. Any amendments to the project must be approved by AUTEC prior to being implemented. Amendments can be requested using the EA2 form.
5. Any serious or unexpected adverse events must be reported to AUTEC Secretariat as a matter of priority.
6. Any unforeseen events that might affect continued ethical acceptability of the project should also be reported to the AUTEC Secretariat as a matter of priority.
7. It is your responsibility to ensure that the spelling and grammar of documents being provided to participants or external organisations is of a high standard.

AUTEC grants ethical approval only. You are responsible for obtaining management approval for access for your research from any institution or organisation at which your research is being conducted. When the research is undertaken outside New Zealand, you need to meet all ethical, legal, and locality obligations or requirements for those jurisdictions.

Please quote the application number and title on all future correspondence related to this project.

For any enquiries please contact ethics@aut.ac.nz. The forms mentioned above are available online through http://www.aut.ac.nz/research/researchethics

Yours sincerely,

Kate O'Connor
Executive Manager
Auckland University of Technology Ethics Committee

Cc: parisa.moradi@aut.ac.nz; Ricardo Sosa

Appendix C. **Participant information sheet**

Participant Information Sheet

TE WĀNANGA ARONUI O TĀMAKI MAKAU RAU

Date Information Sheet Produced:

15 April 2019

Project Title

Ageing with Technology: A study of emotional interactions with smart products.

An Invitation

Hello and Kia ora,

My name is Parisa Moradi. I'm a designer and a researcher born in Iran. I am currently living in Auckland, New Zealand where I am working as a design lecturer and a digital media designer.

This research is being undertake as a part of my PhD degree at the school of Art & Design, AUT. My focus will be on understanding the emotional experience of an older generation of users interacting with social robots to identify any issues that may rise during user-product interaction. I want to see if, by studying the user experience of older people, we can inform the design of new technologies to create safe, inclusive, pleasurable and meaningful experiences.

You are invited to participate in a two-stage research project. Your participation is voluntarily, and you may choose not to participate or withdraw from the study at any time.

- The first stage includes an interview and my observation of you interacting with a social and entertainment robot. This will allow you to share the emotional experiences you have had with technologies and share your immediate response towards the robot. This stage will take approximately 1.5 to 2 hours, with the interview taking between 30 minutes to 1 hour and observation taking up to another hour. The first stage will be a one-to-one session and will be audio and video recorded to be analysed later by me as the researcher.
- During the observation part, I will ask you to wear the Apple Watch provided by AUT so that we can monitor your heart rate to capture any physiological response during the first time interacting with the robot. The Apple Watch was selected to make sure you will be comfortable during the session as it is about the normal size watch and does not require any additional monitoring devices being attached to you. The following photo indicates the look and the size of the watch that you will be only wearing during the observation stage. The Apple watch is an AUT's property and therefore, you cannot keep the watch after the observation stage.

- The second stage will be for you to interact with the robot at your home and self-report your interaction with it over two weeks period in a journal that I will provide. We will have a second interview session after two weeks to discuss any point of view you might have over the experience, given that you have some time to familiarise yourself with the robot. The interview will be audio and video recorded to be analysed later by me.

I understand that you might form a bond with the robot. However, due to budget limitations, the robot will be collected at the end of this stage.

- It is expected that the participants will take appropriate care of the robot. In the unlikely case of an accident in which the robot gets damaged, there will be no cost to the participant. However, it is expected you will return the damaged robot to the researcher as it is AUT's property. The following photo indicates the size and look of the robot that you will be interacting with during these two weeks.

The data that you provide will be used in the researcher's PhD thesis. These data may also be used for academic publications and conference papers. All of the data that will be published with no identifying information. I will use a pseudonym in order to protect your identity and ensure confidentiality.

What is the purpose of this research?

The purpose of this research is to understand how people interact with technical products on an emotional level. I want to understand the key emotional factors that designers should consider in order to design social robots that deliver value to their users. The contribution of my research will be a greater understanding of how emotional design can increase a products' performance, purchasing preference and user satisfaction. I believe that, in an age of increasing technological advances where the user experience is often neglected, this research will highlight the importance of considering the emotional and psychological elements of a product design on the overall consumer experience.

How was I identified and why am I being invited to participate in this research?

You are invited to participate in this research if you are aged between 55 to 85 and if you voluntarily contacted me as the researcher to share your experiences and take part in the study.

How do I agree to participate in this research?

Your participation in this research is voluntarily. The study will neither advantage nor disadvantage you whether you choose to participate or not. You are able to withdraw from the study at any time. If you choose to withdraw from the study, then you will be offered the choice between having any data that is identifiable as belonging to you removed or allowing it to continue to be used. However, once the findings have been produced, removal of your data may not be possible.

Once you decide to participate in the research the consent form will be signed before the actual interview. Both me as the researcher and you as the participant will have a copy of signed consent form.

What will happen in this research?

- The interviews will be structured and one-to-one between me as the researcher and you as the participant. You will be asked several questions about your experience with technology, your thoughts and feelings about smart products, artificial intelligence, and social robots. The interview will be audio and video recorded so it can later be reviewed by the researcher for analysis.
- The second part of the data collection will be observation. I will use video recording and photography to capture your first-time interaction with the given robot after the interview session in your home/work environment that you wish to interact with the robot. I will also capture your heart rate by using an Apple watch to monitor your physiological response toward the robot during the observation stage only.
- You will be asked to keep the provided robot for two weeks and record your daily interactions, feelings, thoughts about the robot in a journal that I will provide for you. You can decide how much information you wish to share with me.
- After two weeks interaction, there will be the second interview session so that you can share your overall experience and opinions about the robot with me.

What are the discomforts and risks?

There is no potential risks or discomforts associated with this research. The data will be gathered through interviews, observation of interacting with a social robot, and any information you wished to record on the journal about your experience of interacting with the given robot. I will not collect sensitive information.

What are the benefits?

The research objective is to help an older generation of users by delivering meaningful experiences for them while interacting with smart products. It will benefit the public as it is aiming to provide a better understanding of the emotional transitioning process that users are going through to adapt to new technologies. The results will provide a better understanding to the way older generation of users feel about technology and social robots emotionally.

The information collected from these interviews will benefit me to obtain my PhD degree in Industrial Design. I will gain a deeper understanding of the user-product interaction and the role of emotional design.

How will my privacy be protected?

The nature of this research is not sensitive. You have the freedom of choosing what information you wish to share with the researcher as well as not answering the questions that you feel uncomfortable with. You can terminate the sessions any time even during any sessions. To protect your confidentiality, you can decide what information you wish to be shared in the research and what information to be excluded. Your personal detail and information will not be mentioned in the research. The videos will be only used for transcriptions and analysis. They will not be published or exhibited. I will take full responsibility to protect these files and keep them secure at AUT premises. The photographs of you interacting with the robots will be shared with you first for your approval. They can only be used for publication or written materials related to my PhD, which in that case I will make sure to cut or blur out your face from the photos so that your identity will be protected.

What are the costs of participating in this research?

The interview will involve your time. The estimated length of the interview will be around 1 hour.

The observation will be after the interview which will take approximately around 30 minutes to 1 hour.

The self-report extended user experience will take 2 weeks of you interacting with the given robot at your preferred time inside your home or selected environment.

The second interview will be run after two weeks approximately around 30 minutes.

What opportunity do I have to consider this invitation?

You can consider participating in this research from the moment you will read this information sheet completely. I would appreciate to know your decision within one month of receiving this participant information sheet. As mentioned, before you have the right to withdraw from taking part in this research even after agreed to participate.

Will I receive feedback on the results of this research?

Yes, a report of the research findings will be given to the participants that showed interest in the research on their consent form. Any academic publication such as conference papers and journals related to this research will be forwarded to you if you wish to receive them.

What do I do if I have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor, Dr Amabel Hunting, amabel.hunting@aut.ac.nz +64 921 9999 ext 8762.

Concerns regarding the conduct of the research should be notified to the Executive Secretary of AUTEC, Kate O'Connor, ethics@aut.ac.nz +64 921 9999 ext 6038.

Whom do I contact for further information about this research?

Please keep this Information Sheet and a copy of the Consent Form for your future reference. You are also able to contact the research team as follows:

Researcher Contact Details:

Parisa Moradi, parisa.moradi@aut.ac.nz +64 921 9999 ext 7741

Project Supervisors Contact Details:

Dr Amabel Hunting, amabel.hunting@aut.ac.nz +64 9 921 9999 ext 8762

A/P Ricardo Sosa, ricardo.sosa@aut.ac.nz +64 9 921 9999 ext 7947

Approved by the Auckland University of Technology Ethics Committee on 15 April 2019, AUTEC Reference number 19/57.

Appendix D. **Consent form**

AUT
TE WĀNANGA ARONUI O TĀMAKI MAKAU RAU

Consent and Release Form

Project title: ***Ageing with Technology: A study of emotional interactions with smart products***

Project Supervisor: ***Dr Amabel Hunting***

Researcher: ***Parisa Moradi***

O I have read and understood the information provided about this research project in the Information Sheet dated 15 April 2019.

O I have had an opportunity to ask questions and to have them answered.

O I understand that taking part in this study is voluntary (my choice) and that I may withdraw from the study at any time without being disadvantaged in any way.

O I understand that the interviews and observation sessions will be audio-taped, video recorded, and transcribed and that notes will be taken during these sessions. However, I understand that pseudonym will be used in order to protect my identity and ensure confidentiality.

O I understand that photographs of me interacting with the robots may be taken to be used in any written material related to Parisa's PhD. However, the photos will be shared with me first for my approval and my face will be cut or blurred out of the photos to protect my identity.

O I understand that the video files and the images that will be taken during the interview and observation can be used for transcription and analysis and may be used as written material as part of Parisa's PhD.

O I permit the researcher to use the photographs and recordings that are part of this project and/or any drawings from them, other reproductions and adaptations from them, either complete or in part, alone or in conjunction with any wording and/or drawings solely and exclusively for the researcher's PhD related works.

O I understand that the robot that I will take home is a property of the AUT and needs to be collected after the two weeks of study.

O I understand that if I withdraw from the study then I will be offered the choice between having any data that is identifiable as belonging to me removed or allowing it to continue to be used. However, once the findings have been produced, removal of my data may not be possible.

O I permit the researcher to use the data captured from the journal that I will record my experience of interacting with robot solely and exclusively for the research purposes. I permit the researcher to use photographs or any drawings that I shared in the journal for the purpose of her research project.

O Any other adaptations from my journal, either complete or in part, alone or in conjunction with any wording and/or drawings can be used solely and exclusively by the researcher for the research purposes, educational exhibition and conferences, examination purposes and related research works.

O I understand that any copyright material created by the filming sessions is deemed to be owned by the researcher and that I do not own copyright of any of the videos.

O I agree to take part in this research.

O I wish to receive a summary of the research findings (please tick one): YesO NoO

Participant's signature : ....

Participant's name : ....

Participant's Contact Details (if appropriate):

....

....

Date :

Approved by the Auckland University of Technology Ethics Committee on 15 April 2019, AUTEC Reference number 19/57.

Note: The Participant should retain a copy of this form

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Appendix E. **Pre-interaction interview questions**

1) When I say the word ‘technology’, what does that mean to you?
2) In general, when the topic of technology comes into a discussion, what emotions come to your mind?
3) Can you give examples of products that have changed your lifestyle more than any others?
   a) What was your experience before interacting with them?
   b) How did this experience change over the years?
4) Have you seen any influence of technology on your daily activities? Can you explain and give examples of how?
5) What has been the influence of technology on health-related and medical-related activities?
6) If you want to think about changes in technology, such as smart products, robots and computer-based technologies, what would be your overall perspective?
7) How do you think technology relates to your values, standards and merits? (Ethics)
8) What about the information that some technologies collect, such as your medical history, relationship or your daily activities, police background check, office and work information? Any information that might contradict your view on privacy (any challenges, fears, benefits), governments, or organizations such as Facebook. Do you have any thoughts about technology and privacy?
9) Have you faced any challenges when interacting with a smart product?
   a) How do you usually try to learn the process of working with them?
   b) What is the experience of learning and adapting to new technology?
   c) Do you seek help when interacting with a new smart product?
10) Do you think technology has an influence on social communication and relationships? How?
11) What Is your opinion about Artificial assistances such as Siri and Alexa?
12) How do you feel about Artificial Intelligence?
13) What do you think about having the presence of AI robots in your daily life?
    a) What do you think they will be most useful for? (Assistants, entertainment and games, education, companions or a combination of all)
    b) What space and environment would you be most comfortable and inspired to interact with AI robots in?

14) How do you feel about having a robot as a social companion?
15) Can you define what companionship means to you?
16) What would be a meaningful and emotional Interaction for you?
17) Do you see any challenges that you might be facing when interacting with a social robot?
18) What would be your ideal way of communication with a social robot?
19) Reviewing the questions, have we missed anything?

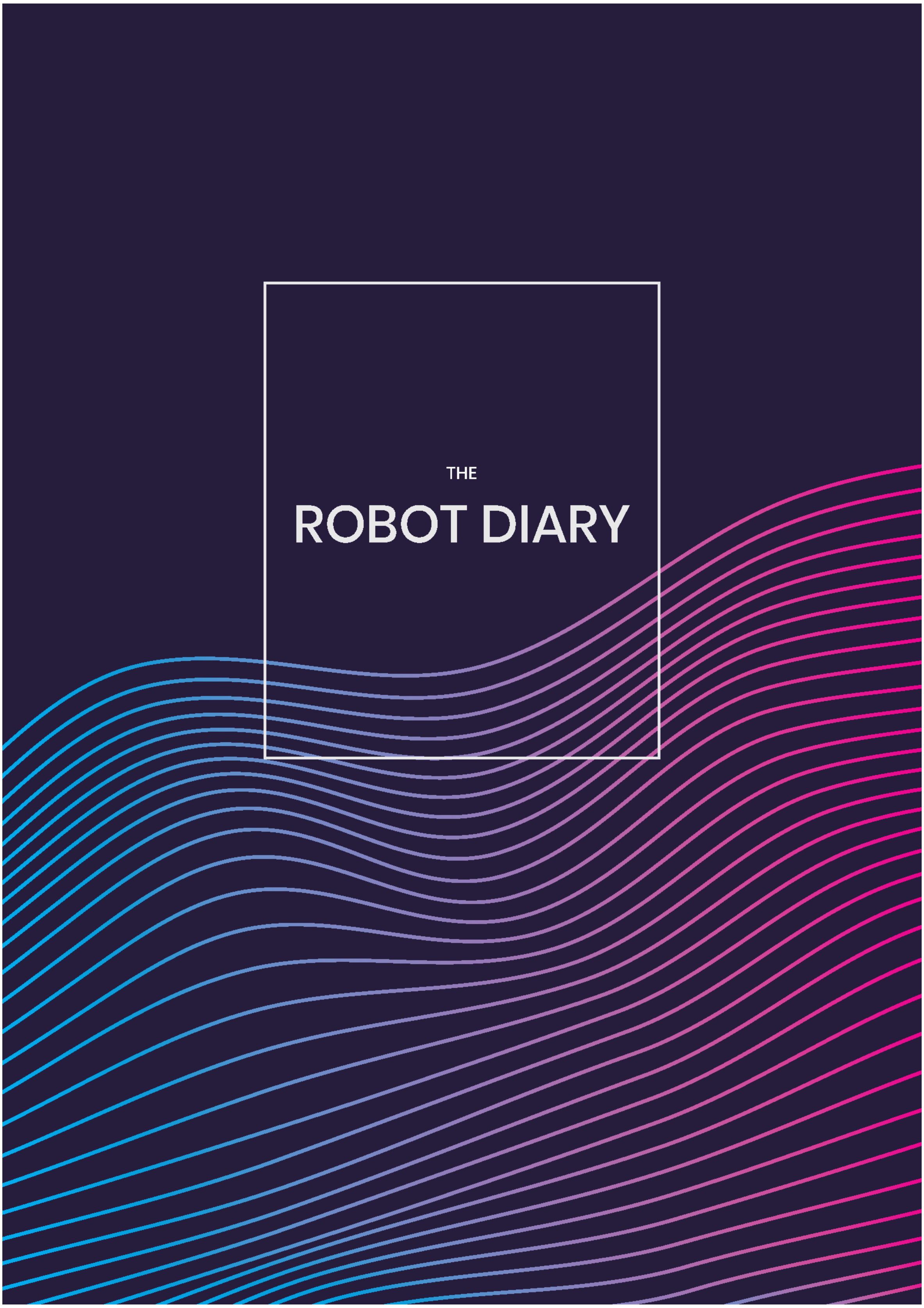
Appendix F. **Post-interaction interview questions**

1) What did you think of the robot?
2) What was your experience of interacting with the robot?
3) How did you feel about the robot?
4) Why do you think you feel that way?
5) What are some ways that the robot was different from other products that you had?
6) What are some ways that it was different from any other companionships that you experienced?
7) Did you give them any nicknames?
8) What space and environment were you most comfortable and inspired to use the robot? Can you explain why?
9) What did you like about the robot?
10) What specific features of the robot impressed you?
11) What were the cons of the robot? What did you not like?
12) Did you face any challenges when interacting with the robot?
13) How was the learning process of working with the robot?
14) What problems did you see with the robot?
15) What features of the robot disappointed you?
16) How likely are you to purchase this robot or a similar robot?
17) If you were to recommend this robot, what would you say about it to convince your friends or family to purchase it?
18) What do you think robots will be most used for?
19) How do you feel about having the robot as a social companion?
    a) Can you define what a social companion means to you?
    b) What characteristics define a social companion?
20) What do you think are the most important aspects of technology for you?
21) Reviewing the topics, have we missed anything?

The next part of my questions is about demographic questions from my participants. Any information that you feel you do not want to talk about or you do not wish to share, please, just let me know, and we can skip it.

22) What is your field of expertise and work area?
23) What is your educational background?
24) Can you describe your typical week? If you work, how many hours do you work? Or any other activities that you would do?
25) In terms of your free time, do you prefer spending more time by yourself or socialising with others?
26) How many people are you living in the house with?
27) Do you have pets?
28) Can I confirm how old you are?

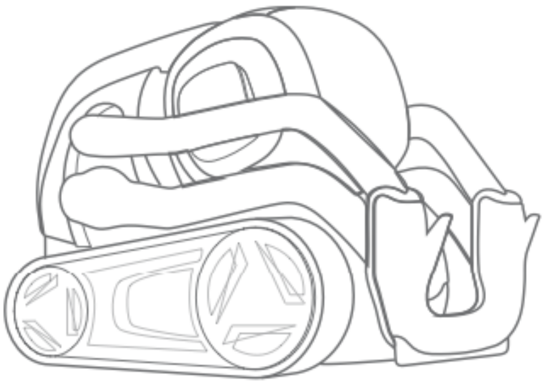
Appendix G. **Participant journal design**



I am excited and grateful that you accepted to participate in my research. This diary is for you to share your reflections and emotions about Vector with me. I hope you enjoy this experience and have fun.

THE

ROBOT DIARY



A personalised name for Vector?

____

DATE / / M T W T F S S

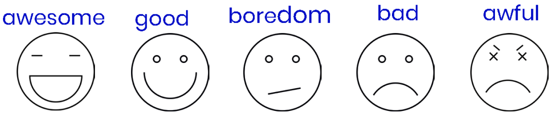
You can mark the day of the week that you are writing your

Here you can mark the time and duration that you interacted

1 am		
2 am		
3 am		
4 am	X	Notes about each interaction with Vector can go here. You can make note about How did the overall experience feel like? what could be different/better? How did it make you feel?
5 am		
6 am		
7 am		
8 am	X	
9 am		
10 am		
11 am		
Midday		
1 pm		
2 pm		
3 pm		
4 pm		
5 pm		
6 pm		
7 pm		
8 pm		
9 pm		
10 pm		
11 pm		
Midnight		

Here you can rate your emotions toward Vector using these emojis

awesome good boredom bad awful



The 14 days tracker.

TRACKING 1 2 3 4 5 6 7 8 9 10 11 12 13 14

MY REFLECTION

You can write notes, sketch, use photos, and reflect on your experience however you like.

You can talk about:

How do you feel about Vector today and why?

Things you liked ...

1.

2.

3.

Things you did not like ...

1.

2.

3.

Thank you for taking the time to participate in my research and share your experience with me.

The information that you are giving to me will make a valuable contribution to my research and the field of design.

Once again, please accept my sincere thanks for so generously sharing the details of your experience.

Kind regards,

Parija