Older Chinese people's attitudes and preferences towards technology and robots

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Abstract

The aging of the global population presents important challenges and opportunities for societies worldwide. Technologies and robots are promising tools in addressing the diverse needs of older people, with the potential to enhance their daily lives, healthcare experiences, and social interactions. Most research on the design of technologies and robots of older people has been conducted in Western countries, therefore, this programme of research investigated the use and attitudes of older people in China to technologies and robots.

A first study explored young Chinese technologists' attitudes toward older people as users of and experts with technology. It found that they have ageist attitudes toward older people as technology users, although they do not have sexist attitudes.

A second study examined older Chinese people’s attitudes toward current technologies they use and their attitudes toward new technologies and robots. It found that they hold positive and negative attitudes toward current technologies but they hold positive attitudes toward new technologies and robots.

A third study investigated older Chinese people’s attitudes and expectations of three different robot types and found that older Chinese people hold positive attitudes toward task-oriented table and movement robots, while they hold varied attitudes toward companion pet robots. The study also found they have different expectations for the different robot types.

A fourth study investigated older Chinese people’s attitudes to a pet robot (MiRo). The study found that older Chinese people hold positive attitudes toward MiRo both as a companion and assistant.

This research contributes to understanding of young Chinese technologists' attitudes toward older people as users of technology. In addition, it has provided an insight into older Chinese people's attitudes toward technologies and robots, especially in relation to different robot types. Finally, it has provided an understanding of older Chinese people's attitudes toward robots for both companionship and assistance in daily life.

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Declarations

I declare that this thesis is a presentation of original work and I am the sole author. This work has not previously been presented for a degree or other qualification at this University or elsewhere. All sources are acknowledged as references.

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Chapter 1 Introduction

The global population is experiencing a profound demographic shift characterized by a significant increase in the number of older people. The rapid increase in life expectancy, coupled with declining birth rates, has contributed to the aging phenomenon witnessed globally. The United Nations (2019) predicts that the global population aged 60 and above will more than double by 2050. This trend poses challenges for healthcare systems, social services, and economies worldwide. Some developed countries are among the regions facing particularly severe aging issues, such as countries in the European Union and Japan. The European Union, for example, is projected to have a rapidly aging population, with the proportion of people aged 65 and over expected to increase from 20% in 2020 to 30% by 2100 (Eurostat, 2021). Japan also stands out as one of the countries with the oldest population, and its proportion of people aged 65 and over is estimated to reach 35% by 2050 (United Nations, 2019).

In China, according to the National Bureau of Statistics of China[1], the number of people aged 65 and over in China was approximately 200 million in 2021. The old age dependency ratio, which is the ratio of the population aged 65 and over to the working age population, was 20.8% in 2021[2]. The proportion of older people in the population is expected to increase rapidly in the coming decades; the number of older people is expected to reach 487 million by 2050 (United Nations, 2019). In addition, China implemented a one-child birth control policy in the 1970s. Thus, another challenge facing China today is the Four-Two-One problem, which refers to the fact that the one-child generation need to provide support for their two parents and four grandparents. In addition, older Chinese people tend to age at home and be cared for by subsequent generations (Chen & Chan, 2011). Therefore, the aging of the population is an important challenge around the world nowadays, which presents huge challenges for society and family members. And this problem is a particularly important challenge for China.

People tend to have negative attitudes towards older people and in particularly hold negative attitudes about older people as technology users (see Chapter 2, section 2.6). In recent years,

[1] URL: https://data.stats.gov.cn/english/easyquery
[2] URL: https://data.stats.gov.cn/english/easyquery.htm?cn=C01

as the global population continues to age, older people have also become technology users who cannot be ignored, and there has been a noticeable trend in the increased adoption of technologies and robots by older people. In some developed countries with aging problems, the use of portable devices such as mobile phones amongst older people has grown. For instance, in the UK, 88% of older people aged between 65 to 74 years now use a mobile phone, as do 75% of older people over 75 years (Ofcom, 2020). In addition, according to a report released by Tencent in 2018[3], the number of WeChat[4] users aged 55-70 reached 61 million in China. The COVID-19 pandemic has further accelerated the adoption of technologies, as older adults sought alternative means to stay connected, access healthcare services, and engage in social activities remotely. Thus, this programme of research started by investigating the attitudes of young Chinese technology students and developers toward older Chinese people as technology users (see Study 1, Chapter 3).

Various types of technologies can support older people, including assistive technologies, healthcare technologies, and information and communication technologies (see Chapter 2, section 2.7). In addition, robots designed for older people may assist them in various tasks and activities and also act as a companion for them in daily life (see Chapter 2, section 2.8). Thus, technologies and robots have immense potential to empower older people, enhance their quality of life, and promote social connectedness.

Therefore, it is particularly important to understand older people’s technology use and attitudes toward technologies and robots. Younger people tend to believe that older people are not expert in using technologies and are reluctant to use them. Recently, researchers have shown an increased interest in investigating older people’s attitudes toward technologies and robots. Unlike this stereotype, many recent studies have found that older people have positive attitudes toward technology and use various technologies in their daily life (see Chapter 2, section 2.9). Similarly, although some studies show that older people have negative attitudes toward robots, the majority of existing studies show that older people hold positive or varied attitudes in relation to different aspects of robots (see Chapter 2, section 2.9).

However, with the rapid development of science and technology, older people are now likely to use technology products such as computers and smartphones, the technology use found in

[3] URL: https://tech.qq.com/a/20181016/013129.htm
[4] A Chinese instant messaging, social media, and mobile payment app developed by Tencent.

previous literature seems to focus on young people rather than on older people. However, the majority of previous studies were conducted in Western countries, and less is known about older Chinese people’s technology use and attitudes. Thus, this programme of research investigated older Chinese people’s technology use and their attitudes toward technology (Study 2, Chapter 4). In addition, most studies about older people’s attitudes toward robots have focused on a single robot type, and have not investigated different robot types. Therefore, this programme of research not only investigated older Chinese people’s attitudes toward robots (Study 2, Chapter 4), but also explored their attitudes and preferences for different robot types (Study 3, Chapter 5). In addition, most of the previous investigations of older people's attitudes towards companion pet robots have been in the context of caring for older people with cognitive problems, such as Alzheimer’s disease, rather than in the context of supporting healthy older people. In these circumstances, this programme of research investigated healthy older Chinese people’s attitudes toward pet robots as a companion in their daily life (Study 4, Chapter 6).

1.1 Research aims and research questions

There are six main aims for this programme of research:

1.To investigate young Chinese technologists’ attitudes toward older Chinese people as technology users and experts (Study 1, Chapter 3).

2. To investigate older Chinese people’s use and attitudes towards technology in their daily life (Study 2, Chapter 4).

5. To investigate older Chinese people’s attitudes towards and preferences for different robot types (Study 3, Chapter 5).

6. To investigate older Chinese people’s attitudes toward pet robots as companions and to assist them in daily life (Study 4, Chapter 6).

1.2 Research approach

This programme of research used a mixed methods research approach. An innovative questionnaire was used in the Study 1 to investigate young Chinese technologists’ attitudes toward older Chinese people as technology users and experts, which quickly provided a measure of participants' ageist and sexist attitudes by asking them to judge a photo of a person (male or female, older or younger). I wanted to get a large sample size to understand the level of young Chinese technologists ageist and sexist attitudes, this short questionnaire provided a structured and standardized approach to data collection. In addition, this method allowed me to gather data and insights from a large sample of participants.

Individual semi-structured interviews were used in Study 2 to explore older Chinese people's technology use and their attitudes toward technologies and robots. The method has the ability to maintain a framework of predetermined questions while allowing for adaptation during the interview process. I could not go to China to do the interviews in person due to the COVID-19 pandemic. Therefore, interviews had to be conducted online, which limited the type of older people who were willing to participate.

Individual and group semi-structured interviews were used in Study 3 to explore older Chinese people's attitudes to different robot types (companion pet robots, task-oriented table robots, and task-oriented movement robots). Participants were shown videos to introduce them to the three types of robots. Group as well as individual interviews were used for both practical and methodological reasons. Recruiting enough older Chinese people was a challenge in the immediate post-COVID period; thus, recruiting enough participants for individual interviews might not have been possible. On the other hand, group interviews provided a platform for group discussion and interaction, which could generate more diverse views from participants. In addition, group interviews could facilitate the exploration of complex topics by allowing participants to build on each other's comments and ideas.

Study 4 used a mixed methods approach, including qualitative and quantitative methods. Individual and group semi-structured interviews were used as a qualitative method to explore older people's attitudes toward a pet robot (MiRo, see Chapter 6, section 6.2.3 and Figure 6.1) to assist and act as a companion to them in daily life. The Almere model questionnaire were used as a quantitative method, to study the attitudes of older people to the pet robot, providing quantitative data on multiple dimensions. Participants watched me interact with MiRo, interacted with the robot themselves and watched videos of MiRo to have a more in-depth understanding of the capabilities of the pet robot.

The overall programme of research uses different methods of presenting information about robots. I introduced some basic information about robots orally in Study 2. Participants watched videos to get information about robots in Study 3. In Study 4, participants interacted with a pet robot MiRo and watched videos about MiRo. Therefore, in the programme of research I planned to compare people's attitudes toward robots in different situations, although there are other variables that were included in the studies, such as the number and type of robots being investigated.

As mentioned above, various research methods were used in this programme of research. In terms of the quantitative research methods, rating scales and ranking were used, such as the Almere Model questionnaire which was used in Study 4, which is a scale based on rating items. To analyse numeric data, a range of statistical tests were used; for example, analysis of variance (ANOVA) was used as a parametric analysis to analyse the results of rating questions; Chi-square goodness of fit test was used as to analyse the result of categorical data.

Regarding the qualitative methods, which were used to investigate older Chinese people's attitudes towards technologies and robots; in this case, I used interviews. To analysis these qualitative data, content analysis and thematic analysis were used the data. Content analysis were used to analyse material for which the information I was seeking was relatively objective and I understood the categories before I started the analysis (although of course I was always open to new information and categories emerging) (Krippendorff, 2018). For example, in Study 2, content analysis was used to explore what digital technologies participants used and their purposes. On the other hand, when analysing qualitative analysis about more conceptually open and complex material, such as participants' attitudes to robots, thematic analysis was used (Braun and Clarke, 2006). For example, in Study 4, thematic analysis was used to analyse participants' expectations of MiRo as a companion.

1.3 Research contributions

To the best of my knowledge, this is the first programme of research to investigate older Chinese people's attitudes toward technologies and robots in a systematic way. The research started by investigating young Chinese technologists' attitudes toward older Chinese people as technology users; then explored older Chinese people's technology use and attitudes toward technologies; finally, investigated their attitudes to different types of robots and in particular, a pet robot.

The main findings of this programme of research are:

1. Study 1 found that both young Chinese technologists and older Chinese people have ageist attitudes about older Chinese people as users of technology. Young Chinese technologists have a 'double standard' for older women whom they perceive negatively in terms of their likelihood of using technologies compared to both old men and young people. In addition, the study found that young Chinese technologists and older Chinese people do not have sexist attitudes towards women or men as users of technology.
2. Study 2 found that older Chinese people use many different types of technologies in their daily lives and use them for different purposes, covering many aspects of their daily lives.
3. Study 2 found that older Chinese people hold both positive and negative attitudes toward technologies in relation to different aspects of technologies. Their positive attitudes were mostly focused on the theme of “Provide access to specific services”, while their negative attitudes were mostly focused on the themes of “Attributes of devices” and their “Negative emotional reactions”. In addition, Study 2 found that although older Chinese people have some negative attitudes toward technologies, they still hold positive attitudes toward new technologies that they have not used before, and have the intention to use them in the future.
4. Study 3 confirmed that older Chinese people hold positive attitudes toward robots in general, but younger old Chinese people (i.e. those in the 60s) and older old Chinese people (i.e. those aged 70 and over) have different attitudes towards different types of robots. Younger old Chinese people have a willingness to use all three robot types (companion pet robots, task-oriented table robots, and task-oriented movement robots), but older old Chinese people do not have such a willingness to use companion pet robots.
5. Study 4 found that the Almere model can be used to assess older Chinese people’s attitudes toward pet robots, which can assist in studying the attitudes of older people to robots, providing quantitative data on multiple dimensions. The results from the Almere model as a quantitative method aligned well with the qualitative data from the interviews and can complement the qualitative data.
6. Study 4 provides a new concise model based on the dimensions of older Chinese people’s attitudes to pet robots, which can provide a useful and efficient method to explore older Chinese people’s attitudes toward robots.

7. The overall programme of research also found that different methods of presenting information may have an impact on the results of the study when comparing the results from different studies.
8. In addition, the attitudes of older Chinese people towards robots may also change with their knowledge of robots. In Study 2, participants only received information about the robots through my oral description; in Study 3, participants watched three videos to have a more detailed understanding about the robots; finally, in Study 4, participants not only watched videos about the MiRo robot, but also watched me interact with the actual pet robot and interacted with the pet robot themselves. The participants' attitudes and concerns about robots were slightly different in these three studies; participants' attitudes toward robots gradually became more positive as the methods of presenting information became more detailed and as participants deepened their understanding of robots. Although the number and type of robots being presented was different in the studies, this is still might a reason that causes older Chinese people to have more positive attitudes toward robots.

In addition to these findings, the overall contributions of this research include:

1. This programme of research investigated young Chinese technologists' and older Chinese people's attitudes toward older Chinese people as technology users, which fills a gap in the research on Chinese people's attitudes toward older Chinese people as technology users and identifies that there are different views between young and older Chinese people.
2. This programme of research contributes to our knowledge of older Chinese people's daily technology use, including their purposes for using technologies and how they learn to use technologies. This could help young developers to design technologies that match older Chinese people's technology use, and create ways to help them to learn to use technologies easily.
3. This programme of research enhanced our understanding of older Chinese people's attitudes toward technologies in terms of their positive and negative attitudes, which could help us design technologies that meet older Chinese people's needs and improve their experience of technology.

4. A perspective on older people’s attitudes and expectations for different robot types was offered by the programme of research, which could help us to understand which type of robot is more suitable for older Chinese people to use in daily life and is most acceptable to them.
5. This work generated insight into companion pet robots to assist healthy older people and act as a companion to them in daily life, rather than in the context of older people with cognitive problems or those living in an institutional environment.
6. This programme of research provides a new concise quantitative model of attitudes to robots that could be used to explore older people’s attitudes toward robots in further research.

1.4 Thesis structure

This thesis is organised into seven chapters and a number of appendices, containing material for the various studies. The remaining chapters are organised as follows:

Chapter 2 presents a review of literature on areas relevant to programme of research. This includes definitions of older people, the demographics of aging, problems of old age in China, people’s attitudes toward older people as users of technologies, technologies for older people, robots for older people, and older people’s attitudes toward technologies and robots.

Chapter 3 presents Study 1, the investigation of Young Chinese technologists’ attitudes about older Chinese people as users of technology, and whether their attitudes differ from those of older Chinese people. The study used a questionnaire to investigated participants’ attitudes. 85 young Chinese people (aged 20-33 years) and 101 older Chinese people (aged 60-85 years) participated in the study.

Chapter 4 presents Study 2 which investigated older Chinese people’s technology use and attitudes in the context of their daily lives, and their attitudes toward new technologies and robots. Semi-structured online interviews were used in the study, 25 older Chinese people (aged 60-69; 13 women, 12 men) participated in the study.

Chapter 5 presents Study 3 which investigated older Chinese people's attitudes and preferences for different robot types (companion pet robots, task-oriented table robots, task-oriented movement robots). Individual and group semi-structured interviews were used in the study; I showed participants three videos to introduce the three robot types, and then explored their perceptions about each robot type. 53 older Chinese people (aged 60-93; 16 men, 37 women) participated in the study.

Chapter 6 presents Study 4 which investigated the attitudes of older Chinese people toward the MiRo pet robot and aimed to understand older Chinese people's attitudes and expectations of the MiRo robot in both companion and assistance aspects. This study also examined whether the Almere model would support the results of interviews; and explored whether there is a smaller number of underlying constructs that would account for older Chinese people's attitudes to robots. Individual and group semi-structured interviews, and the questionnaire method were used in the study to explore older Chinese people's attitudes toward the MiRo robot. Participants watched me interact with MiRo, interacted with MiRo themselves and watched a video about the MiRo robot to gain more information; then, participants took part in semi-structured interviews and completed the adapted Almere model questionnaire. 65 older Chinese people (aged 60-93; 39 women, 26 men) took part in the study.

Chapter 7 presents the overall discussion and conclusions of this programme of research, the contributions of the research, limitations and reflections on the work, as well as recommendations for future research.

Chapter 2 Literature Review

2.1 Introduction

This chapter presents a review of literature relevant to my programme of research. It includes the definitions of older people, demographics of aging, problems of old age in China, research on people's attitudes toward older people as users of technologies, technologies and robots that were designed for older people, and the research on older people's attitudes to technologies and robots in general.

2.2 Definitions of older people

"Older" people are commonly defined as individuals who have reached a certain age threshold, typically 60 or 65 years old. However, the definition of older people can vary depending on the organization or country. The World Health Organization (WHO)[5] and the United Nations (UN)[6] define older people as those aged 60 and over, while the European commission[7]defines older people as those aged 65 and over. In many developed countries, older people are generally defined as those aged 65 or older, because they are more likely to have access to state-funded or affordable healthcare, social services, and financial resources; thus, they tend to have longer life expectancies and lower rates of disability and disease. for example, the USA[8] defines older people as those 65 years and older; In Japan, many scholars and officials have proposed redefining older people as aged 75 years and older (Ouchi et al., 2017).

In contrast, older people in developing countries often face more significant health and economic challenges. They may have limited access to healthcare and social services, which can lead to higher rates of disability and disease. Thus, many developing countries define older people as aged 60 and older. For example, India defines adults who are over 60 years old as

[5] URL: https://www.who.int/health-topics/ageing#tab=tab_1
[6] URL: https://emergency.unhcr.org/entry/43935/older-persons#:~:text=An%20older%20person%20is%20defined,or%20age%2Drelated%20health%20conditions
[7] URL: https://ec.europa.eu/eurostat/documents/3217494/11478057/KS-02-20-655-EN-N.pdf/
[8] URL: https://www.ncbi.nlm.nih.gov/books/NBK235450/

older people.[9] The United Nations Minimum Data Set (MDS) Project defined older people in Africa is 60 years older (Kowal & Dowd, 2001).

Overall, this discussion shows that there is no uniform standard definition of older people throughout the world. The definition of older people can vary depending on the organization or country, and may be influenced by factors such as social environment and life expectancies.

2.3 Demographics of aging

The world's population is aging at an unprecedented rate, with significant implications for health, social, and economic policies. Demographic trends show that the proportion of older people in the population is increasing, while the proportion of younger people is decreasing (United Nations, 2019). The aging of the population is primarily the result of declining fertility rates and increasing life expectancies, which would cause the lower old dependency ratio[10]. For example, Figure 2.1 shows it is expected that by 2060 there will be two young people supporting one older person in the UK (United Nations, 2022). In many developed countries, fertility rates have fallen below the replacement level, meaning that there are fewer children being born than there are people dying. At the same time, advances in medicine and public health have contributed to increased life expectancies, leading to a growing number of older people in the population. This trend is expected to continue in the coming decades, with the United Nations projecting that the global population aged 60 and over will more than double by 2050. According to the United Nations (2019), the world's population aged 60 years and over is expected to reach 2.1 billion by 2050, representing an increase from 900 million in 2015. The aging of the global population has important implications for healthcare systems, social services, and economies worldwide. The demand for healthcare and social services is likely to increase, while the labour force is likely to decrease, leading to potential economic challenges. Therefore, policies and interventions that address the needs of aging populations are essential for ensuring the well-being of individuals and societies worldwide.

[9] UEL: https://ruralindiaonline.org/hi/library/resource/elderly-in-india-2021/
[10] Old dependency ratio: the ratio of the population aged 65 and over to the working-age population.

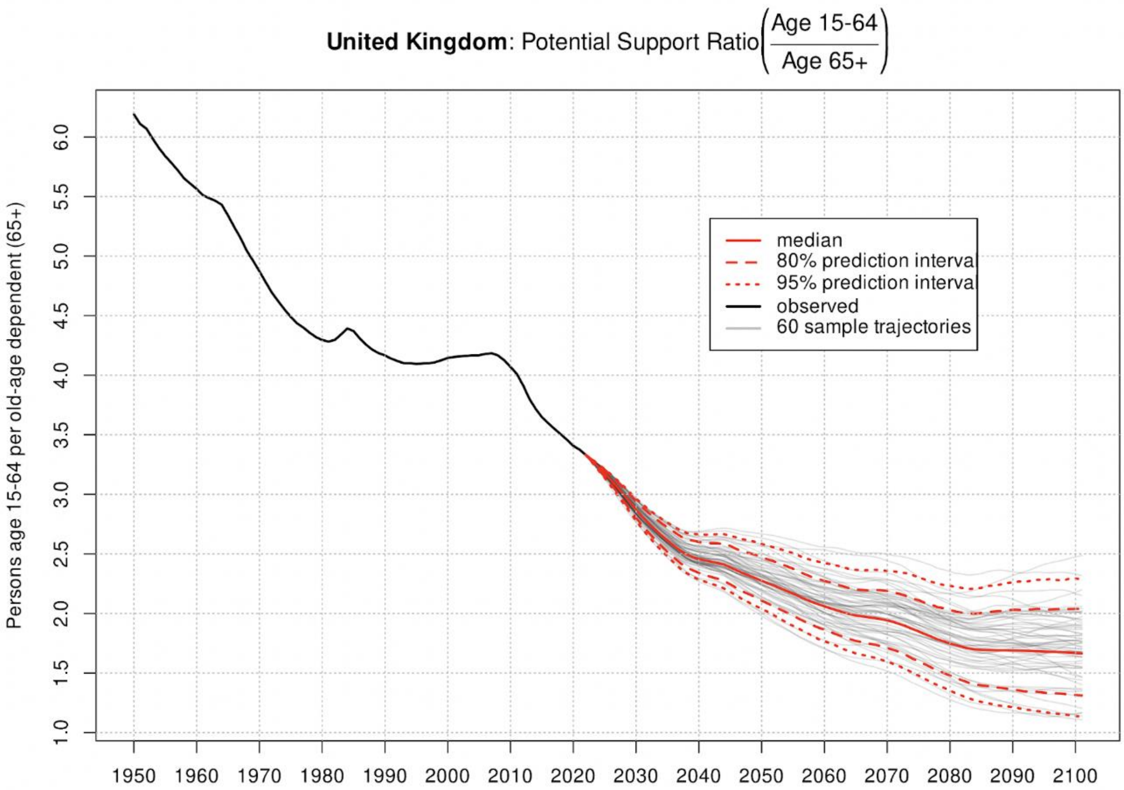


Figure 2.1: Potential Support Ratio prediction in UK (Source: https://population.un.org/wpp/)

In addition, the problem of population aging is more serious in some developed regions and countries. According to Eurostat (2021), the proportion of people aged 65 and over in the EU is projected to increase from 20% in 2020 to 30% by 2100. furthermore, Japan is one of the countries with the oldest population in the world, with 28% of its population aged 65 years and over in 2019. This proportion is projected to reach 35% by 2050 (United Nations, 2019).

As the number of older people in the population grows, so too does the demand for health care services and long-term care. This can place a strain on health care systems, particularly in countries with older populations and fewer younger people to provide care. Additionally, the aging of the population can have economic consequences, as older people are more likely to be retired and require support from government programmes such as pensions and social security. This can lead to increased public spending on these programmes and a strain on government budgets. On the other hand, it also has significant effects on individuals and families. With increasing life expectancy, older adults face the prospect of living longer with chronic diseases and disabilities, which can lead to diminished quality of life and increased healthcare costs for the family. Furthermore, aging can also lead to changes in family dynamics, such as shifts in caregiving responsibilities, family members may have to take on caregiving roles, which is also causes a great burden to the family.

In conclusion, the aging demographic is a growing concern worldwide; the aging of the world's population is a significant trend that is likely to continue in the coming decades. The aging of the population has significant consequences for both society and individuals, particularly in terms of the burden it places on healthcare systems, social services, and families. Therefore, it is important to deal with this challenge to address the consequence of an aging demographic. Thus, technologies and particularly robots, have the potential to be part of the way of dealing with these changes to provide support for older people and help young people to take care of older people.

2.4 Problems of the aging population in China

As the second most populous country in the world, China is currently facing serious challenges related to its aging population. As of 2021, the number of people aged 65 and over in China was approximately 200 million. The potential support ratio, which is the ratio of the population aged 65 and over to the working-age population, was 20.8% in 2021[11]. According to the United Nations (2019) China's population is aging at an unprecedented rate, and the proportion of older people in the population is expected to increase rapidly in the coming decades; the number of the older population is expected to reach 487 million by 2050. Thus, Figure 2.2 shows there are around six young people to support one older person in 2020, but only two young people will support one older person in 2050 (United Nations, 2022).

[11] URL: https://data.stats.gov.cn/english/easyquery.htm?cn=C01

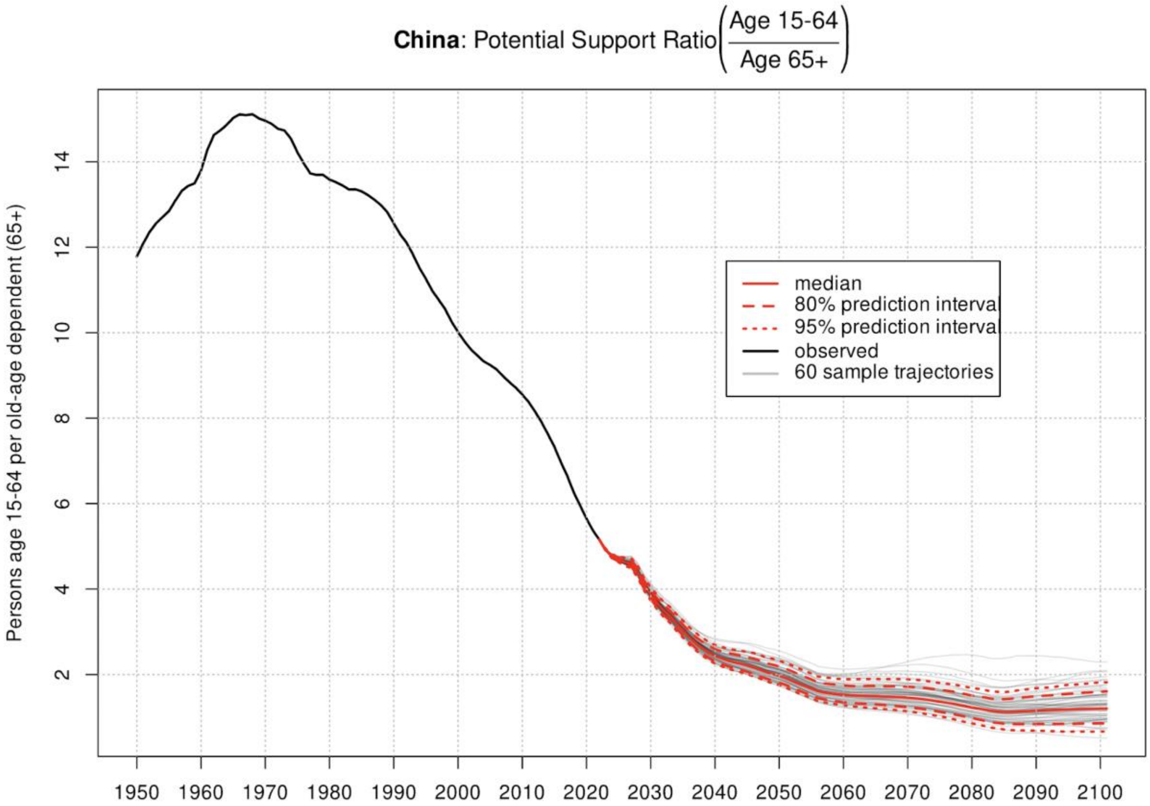


Figure 2.2: Potential Support Ratio prediction in China (Source: https://population.un.org/wpp/)

The aging of the population and lower old age dependency ratio in China can be attributed to several factors, including the one-child policy, increased life expectancy, and urbanization. The one-child policy, implemented in 1979, significantly reduced the birth rate in China, leading to a decrease in the number of young people entering the workforce. Meanwhile, life expectancy in China has increased significantly, from 41 years in 1950 to 77 years in 2019 (World Bank, 2021). Urbanization has also contributed to the aging of the population, as younger people move to cities to work, leaving behind a disproportionately older rural population.

The consequences of an aging population in China are important and wide-ranging. One of the most significant consequences is the increasing burden on the social welfare system, including healthcare, pensions, and social services. As the population ages, the demand for healthcare services and long-term care will increase, putting pressure on the healthcare system and government finances. At the same time, the shrinking workforce will have to support a growing number of retirees, putting additional pressure on the pension system (Chen & Liu, 2009).

Accordingly, older Chinese people face many problems, such as their health status, low pension insurance rate, the daily care they require, health expenses, and long-term care costs (Jiang et.al, 2016; Mao et.al, 2020). In addition, the traditional Chinese model of care for older people model relies on the support of family members. However, because of the one-child policy and accelerated urbanization, many older Chinese people do not live in the same city as their children; thus, families lack the ability to care for their older people, and they need to take care of themselves.

2.5 The nature and theories about attitudes

There have many different definitions for “attitude”, I will take the definition provided by Albarracin and Shavitt (2018) that an attitude is “a person’s evaluation of an object on a favourable to unfavourable continuum” (p300). Attitudes can be expressed directly, if participants are asked to express their attitude towards something; in addition, attitudes could also be measured directly through various questionnaires. But in a semi-structured interview, participants may often express their attitude indirectly, known as implicit expression (Albarracin & Shavitt, 2018). Attitudes are complicated and multidimensional, but they have been recognized as influential factors that can guide and predict human actions, and play a pivotal role in influencing human behaviour. In research going back to the 1960s, Rosenberg and Hovland (1960) proposed the Tripartite Model of Attitude structure, which splits attitude into three components: affect, behaviour, and cognition. The Affective component refers to the emotional or feeling aspect of an attitude. The Behavioural component refers to the action aspect of an attitude, representing a person's actions or intended actions toward the object of the attitude. The Cognitive component refers to the thought-based aspect of an attitude. It includes people's beliefs, thoughts, and knowledge about the object of the attitude. The Tripartite Model proposes that these three components are interconnected, influencing and reinforcing each other. Changes in one component may lead to changes in the others. In addition, Samra (2014) delved into the concept of attitude and its impact on various aspects of life. He also explored how attitudes are formed, influenced, and can be changed over time and suggested that attitudes should be measured through multiple methods. For example, behavioural data could be assessed based on the degree or intensity of involvement with the object of the attitude; cognitive aspects could be assessed using semantic differential scales or open-ended responses. Therefore, my research programme used different methods, such as interviews and questionnaires, to investigate older Chinese people’s attitudes toward technology and robots.

Rosenberg (1956) also explored the relationship between the cognitive components of attitudes which he called their cognitive structure. He investigated how people's cognitive components influence their emotional responses to various stimuli and situations. Rosenberg discussed the role of cognitive consistency in shaping attitudes and emotions, emphasizing the importance of congruence between cognitive beliefs and affective responses. Rosenberg also examined the impact of cognitive dissonance on attitudes and emotions, highlighting how discrepancies between beliefs and behaviours can lead to psychological discomfort. Through empirical research and theoretical analysis, Rosenberg provided insights into the complex interplay between cognitive processes and emotional reactions, shedding light on the mechanisms underlying the affective component of attitude.

In addition, people’s expectations are usually related to their attitudes, which affect their attitudes and hence their behaviour. Wigfield, Eccles, and their colleagues proposed the expectancy-value model based on these ideas and conducted a series of studies to validate the model (Wigfield, 1994; Wigfield & Eccles, 2001). The Expectancy-Value Model seeks to predict individuals' choices and behaviours based on their expectations and the perceived value of outcomes associated with those choices for them. The model proposes that motivation is a function of both expectancy and value. The motivation to engage in a particular behaviour is higher when an individual believes that their effort will lead to a positive outcome (high expectancy) and when they place a high value on that outcome. This model provides a framework for understanding how individuals' beliefs and attitudes shape their motivation to act in various domains. Wigfield and colleagues proposed that people's motivation to act is influenced by two main factors: their expectations for success and the subjective value they place on the task. According to this model, people are more likely to be motivated to pursue a task if they believe they can succeed at it (expectancy) and if they perceive the task as personally meaningful or important (value). The model also suggests that people's motivation can be influenced by their perceptions of the task's difficulty and the perceived importance of doing well. This model was originally proposed for the domain of education (Wigfield & Eccles, 2001). In educational settings, teachers and educators often use the Expectancy-Value Model to understand and enhance students' motivation. By addressing both the expectancy and value components, educators can design learning experiences that are more likely to engage and motivate students (Shang et al., (2023). Although this model is mainly used in the field of education, this model also reveals the impact of expectations on people's behaviour more generally. My research investigates the attitudes of older Chinese people towards technology and robots, including investigating their expectations of robots.

Another important relevant theory is the Theory of Planned Behaviour (TPB) that aims to explain the relationships between attitudes, intentions and behaviour. It proposes that behaviour is guided by three primary factors, “Attitude Toward Behaviour”, Subjective Norms and Perceived Behavioural Control (Ajzen, 1991). Ajzen et al (2018) discussed the complex relationship between attitudes and behaviour. They proposed that attitudes influence behaviour through a process involving intention formation, which is shaped by beliefs about the outcomes of the behaviour and evaluations of those outcomes. Thus, there is a relationship between attitudes and behaviour, and attitudes could affect behaviour. Understanding older people’s attitudes towards technology and robots is important, as it could influence their behaviour and help them accept and use these technologies in the future. I will discuss theories about people’s attitudes towards technologies in particular in Section 2.9.1.

2.6 People’s attitudes toward older people as users of technologies

2.6.1 Sexism and ageism in China

Sexism and ageism are prevalent issues in many societies around the world, and this phenomenon also exists in Chinese society.

Despite progress towards gender equality in recent years, sexism is still pervasive in China. Gender-based discrimination affects women in various aspects of life, including in family, education, employment. It has been observed that households in China, especially in rural areas, demand greater compensation when a boy is born as compared to when a girl is born, which was measured and tested directly by using household expenditure and food consumption data (Tian et al, 2018). In relation to education, the gap has been decreasing gradually with time, and there was almost no noticeable gender inequality in urban areas, but there is still gender inequality in educational achievement in rural areas (Zeng et al, 2014). In the labour market, women who plan to have children are more likely to suffer gender discrimination when they find a job (Liu, 2021).

Respect for older people is an important value in Chinese traditional culture. It is deeply rooted in Confucian philosophy that emphasizes the importance of family, filial piety, and the intergenerational transmission of values and knowledge (Chan & Tan, 2004). This traditional culture is reflected in every aspect of Chinese society. Older people tend to receive more respect and preferential treatment in such circumstances, especially in attitudes to taking care of older people. In today's society, this culture still deeply affects Chinese people and motivates them to care for older people. But in the modern context, Chinese individuals have customized elements of this cultural expectation of respect for older people to better fit their own real-life experiences and circumstances in their daily acts of caregiving (Wong & Chau, 2006).

Although Chinese society generally respects older people, age discrimination exists in some areas, such as recruitment. If a job requires only basic technical skills, knowledge and experience, then the age limit will be more relaxed (Wu & Sun, 2021). However, if the job has more advanced requirements requiring a greater investment of time and effort from the job seeker, then the maximum age limit will be lowered.

Despite significant progress in gender equality and anti-discrimination in recent years, China continues to face challenges related to gender and age discrimination. In conclusion, sexism and ageism are issues in China that impact various aspects of society.

2.6.2 Young people’s attitudes toward older people as users of technologies

It is well-known that young people in many societies have negative attitudes and beliefs about older people. A number of studies have investigated the attitudes of different groups of young people towards older people. A study conducted with Australian medical and allied health students found that they hold positive attitudes toward older people (Lin et al., 2010). In contrast, more recent studies have found that young people hold negative attitudes toward older people. Goriup and Lahe (2018) investigated Slovenia young people's attitudes toward older people; the study found that young people often have a negative attitude towards older people, especially those with less knowledge about aging. Another study was conducted with Egyptian nursing students, and found that participants had an unsatisfactory level of knowledge regarding elderly care and demonstrated negative attitudes toward older people (Mohammed & Omar, 2019). In addition, older women often receive more negative views than older men; thus, there is often a "double standard" in attitudes and beliefs toward older women (Sontag, 1997).

The existing literature on people’s attitudes towards older people tends to focus particularly on people who will interact with older adults, such as nurses and nursing students (Alquwez et al., 2018; Flood & Clark, 2009). As technology continues to evolve rapidly, it is essential to consider the attitudes of young people toward older people as users of technologies. However, there is a relatively small body of literature that is concerned with those who create technologies for older people. Petrie (2018) researched this topic with 189 young British computer science students aged between 18 and 28 years older (who were very predominantly male); they were shown a picture of a male or female individual who was either young or old. Then they answered a questionnaire to assess their attitudes toward the person's likelihood and expertise in using technologies. She found that they thought that older people were less likely to use a range of digital technologies (desktop computers, laptop computers and smartphones) and less likely to be expert in using them. While she found no difference in beliefs that women would use these technologies less than men, there was a difference in beliefs about expertise, with women perceived as being less expert than men. However, she found no evidence of a “double discrimination” against older women being seen as less likely to use these technologies or less expert with them than the other groups.

Hallewell-Haslwanter and Takacs (2022) extended Petrie’s study to examine whether ageism and assumptions regarding older people's computer proficiency also affect the development of systems specifically designed for them. Participants were shown a picture of a male or female individual who was either young or old. Then they answered a questionnaire to assess the computer literacy of the person depicted and finally asked about appropriate design aspects for them. 200 valid questionnaires were collected from students from the Austrian University of Applied Sciences. The study confirmed that the students had biases, which could impact the acceptance of future systems by older people, potentially hindering their ability to benefit from them. The study found that the aspects of designs mentioned for older people were different from those mentioned for younger people. For younger people, many aspects considered valuable and desirable were mentioned, while for older people, the focus was on accessibility and usability, almost excluding valuable and desirable aspects.

Overall, a considerable body of research has been produced on young people's attitudes toward older people. Although many studies found that young people tend to have negative attitudes toward older people, many studies also identified that young people hold positive attitudes toward older people. However, in terms of young people's attitudes toward older people using technologies, the existing studies show that young people hold negative attitudes toward older people. On the other hand, much of the current literature on young people's attitudes toward older people pays particular attention to people who will interact with older people, such as nurses and nursing students; few studies have investigated the attitudes of the young people who will develop technologies for older people. In addition, the existing studies were conducted in Europe, which represents only young people from Western countries. Therefore, my first study extended Petrie's study to investigate the perceptions of young Chinese university students studying technology-related subjects and young Chinese people working in technology-related industries of younger and older men and women as users and experts of computers and smartphones. It then compared these perceptions with the perceptions of older Chinese people.

2.7 Technologies for older people

The aging of the global population has led to a growing need for technologies that can support older people's daily lives and enhance their quality of life. There are various types of technologies that can support older people, including assistive technologies, healthcare technologies, and Information and communications technologies (ICT). These technologies for older people can provide many benefits, including promoting independence, reducing social isolation, and improving health outcomes.

Assistive technologies can support older people's independence and safety, such as smart wheelchairs that can help older people with mobility impairments and improve their quality of life (McCreadie, 2002; Sinn & Poupart, 2011). Healthcare technologies can enable older people to manage their health conditions from home, reducing the need for hospital visits and improving their quality of life; these include remote patient monitoring systems, such as blood pressure monitoring; healthcare technologies plays an important role in helping caregivers and family members check older adults' health status and activities at any time (Czaja, 2016). ICT can provide opportunities for older people to connect with others and participate in social activities, improving their mental health and well-being. This type of technology can help older people stay in touch with friends and family, establish new relationships and receive information about society (Czaja, 2017).

In conclusion, technologies for older people can provide significant benefits for older people, caregivers, and healthcare providers. Assistive technologies can support independence and safety, healthcare technologies can improve health outcomes and reduce healthcare costs for older people, and ICT can combat social isolation and improve mental health and well-being.

2.8 Robots for older people

A particular type of technology which has been extensively explored as a way of supporting older people, is robotic technology. Robotic technology has been recognized as one of the most promising areas of research in this field, with robots being designed to assist older people in various tasks and activities of daily living.

There are many different kinds of robots that can help older people. Companion robots have been widely used in some elderly care institutions, and the existing literature on companion robots is extensive and focuses particularly on providing companionship to improve the health and psychological wellbeing of older people (Robinson, MacDonald et al., 2013; Tkatch et al., 2021; Wada et al., 2003), as well as stimulating social interaction and communication for people with dementia as a therapeutic purpose (Heerink et al., 2013; Yu, et al., 2015). Most companion robots in the commercial market are designed in the shape of animals, such as seals, dogs, cats, and rabbits. Thus, most of them are companion pet robots, which have the ability to listen, respond to speech, recognize touch and detect sound and light. For example, Paro is the one of the most popular companion pet robots, in the shape of a baby seal, and it has reactions when the user touches it, but it cannot move around (Wada & Shibata, 2007) (Figure 2.3). Given this emphasis on pets, this research programme will focus on companion pet robots.

Figure 2.3: Paro (Source: Wada & Shibata, 2007)

Figure 2.4: Pearl (Source: Pollack, et al., 2002) (left)
Figure 2.5: CM robots (Source: https://www.orionstar.com/bxiaomidp.html) (right)

Task-oriented robots, which try to provide physical and cognitive support (Petrie & Darzentas, 2017), such as physical tasks (picking up objects and carrying objects), rehabilitation tasks (walking assistance), health-monitoring tasks, reminder tasks, chore tasks, fall detection tasks (Graf et al., 2004; Wu et.al., 2014). For example, Care-O-Bot is a task-oriented robot, which navigates autonomously and safely in an indoor environment, Care-O-Bot can communicate with or guide older people and assist them in their homes. It also can help users to pick up and bring different objects (Graf et al., 2004). Figure 2.4 shows an autonomous mobile robot, Pearl, which can remind older people about routine activities such as taking medicine and eating, it also can guide older people through their environments (Pollack, et al., 2002).

There are many different kinds of task-oriented robots with different shapes and functions. Therefore, task-oriented robots can be divided into two types in this study, task-oriented table robots and task-oriented movement robots. Task-oriented table robots are robots that are designed to perform specific tasks on a flat surface, typically a table or a workbench; for example, the Xiaomi Sound that was developed by Xiaomi Corporation, and Alexa from Amazon are widely used by young people. Task-oriented movement robots are robots that are designed to perform tasks that involve movement ability; for example, the CM movement robot developed by Cheetah Mobile Inc, are widely used in shopping malls, restaurants, and museums in China (see Figure 2.5). These two types of robots are widely used in the current commercial market, but the main user groups of these two kinds of robots are currently not older people.

Taken together, robots for older people are mainly used to solve the problems of loneliness and physical decline of older people; thus, there are companion and task-oriented robots accordingly. Companion robots are mainly in the form of pets to provide companionship to older people, and task-oriented robots appear in different forms due to the different assistance functions they provide.

2.9 Older people’s attitudes toward technologies and robots

2.9.1 Theories and methodologies for studying older people’s attitudes and concerns of technologies and robots

As discussed in section 2.5, people’s attitudes are complicated and multidimensional, but do affect people’s behaviour. Thus, in order to explore the relationship between older people’s attitude and their use of technology, many studies have investigated their attitudes towards technologies and robots. There have many different kinds of methods used to investigate older people's attitudes of technologies and robots. Both qualitative and quantitative methods have been used in different studies. In terms of the qualitative methods, interviews and focus groups have been widely used. Interviews are a popular qualitative research method that involves a conversation between the researcher and the participants in order to collect data about a particular topic, which allow researchers to collect rich and detailed data about a participant's experiences, attitudes, and opinions. Focus groups provide a platform for group discussion and interaction, which can generate more diverse and dynamic data from participants. In addition, focus groups can facilitate the exploration of complex topics by allowing participants to build on each other's comments and ideas (Flick., 2022).

On the other hand, many studies investigating older people's attitudes toward technologies and robots have used questionnaires. In terms of measuring people's attitudes toward technologies, as mentioned earlier, attitudes are often related to people's behaviour and can predict behaviour. Thus, many technology acceptance models include constructs that investigate people's attitudes. The Technology Acceptance Model (TAM) (Davis, 1985) has been widely used and has been modified to suit different contexts. It attempts to identify factors that influence a user's intention to use a technology as a predictor of their actual use (Davis, 1985). TAM suggests that the perceived ease of using a technology and the perceived usefulness of the technology are the primary factors that influence users' intention to use it (Davis, 1985). The Unified Theory of Acceptance and Use of Technology (UTAUT) expanded on TAM by defining perceived usefulness as Performance Expectancy, and perceived ease of use as Effort Expectancy. UTAUT also includes Social Influence and Facilitating Conditions as additional factors influencing technology acceptance (Venkatesh et al., 2003). However, these two questionnaires were not particularly designed to investigate older people's attitudes toward technology. A senior technology acceptance model (STAM) was proposed to assess older people's attitudes toward technology, which was developed from TAM and UTAUT (Chen & Chan, 2014). Figure 2.6 shows the structure of the STAM model: solid lines indicate statistically significant paths, dotted lines indicate non-significant paths). the STAM model proposes that older people's "Attitudes towards Use" is affected by "Perceived Usefulness", "Perceived Ease of Use" and "Facilitating conditions". The construct of "Perceived Usefulness" is affected by "Perceived Ease of Use", "Gerontechnology self-efficacy", "Facilitating conditions" and "Social relationships". The construct of "Perceived Ease of Use" is affected by "Gerontechnology self-efficacy", "Gerontechnology anxiety", "Facilitating conditions", "Health conditions", "Attitudes to life and satisfaction" and "Physical functioning". The construct of "Usage Behaviour" is affected by all constructs except "Perceived Usefulness" and "Perceived Ease of Use". Although people's "Usage Behaviour" is not affected by their "Attitudes towards Use" directly, the STAM model shows older people's "Attitudes toward Use" and "Usage Behaviour" were affected by similar constructs. STAM highlights the aspect of physical, psychological and social characteristics associated with ageing affect older people's interactions with technologies, specifically in the context of gerontechnology, which had not been considered in TAM and UTAUT. The STAM Questionnaire has 38 items in total and consisted of 11 constructs. Although TAM, UTAUT and STAM have been widely used in previous studies to investigate people's attitudes, most studies do not investigate whether "Intention to use" actually predicts use of technology.

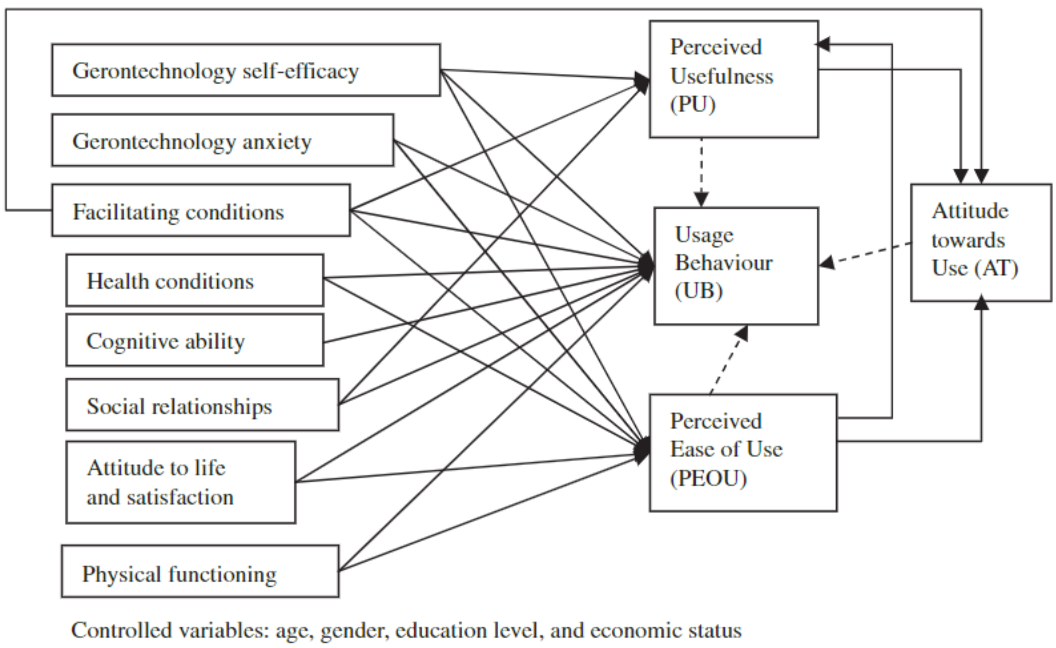


Figure 2.6: A senior technology acceptance model (STAM) (Source: Chen & Chan, 2014)

In terms of investigating older people's attitudes toward robots, Heerink et al. (2010) developed a modified version of UTAUT, the Almere model, to assess older people's acceptance of what they termed "assistive social agent technologies", which have similarities to robots. The Almere model has 41 items grouped into 12 constructs (See Appendix I). Two constructs were taken from UTAUT, "Perceived Ease of Use" and "Perceived Usefulness". In addition, the Almere Model has other constructs, which include "Perceived Enjoyment", "Social Presence", "Perceived Sociability", "Trust", and "Perceived Adaptivity". It is important to note that the Almere Model concentrated on the influence of social factors influencing older people's acceptance of technology, and was investigated in relation to assistive social agent technology. The relationship between each construct (Figure 2.7) was validated by three controlled experiments, Netherlands participants interacted with assistive social agents in Heerink's study. Figure 2.7 shows the structure of the Almere model, solid lines indicate statistically significant paths. The Almere model shows older people's actual "Use" robots was affected by "Facilitating Conditions", "Social Influence" and "Intention to use". Older people's "Intention to Use" robots was affected by "Social Influence", "Attitudes", "Perceived Usefulness", "Perceived Ease of Use" and "Perceived Enjoyment".

However, the Almere model constructs are largely theoretically derived from the TAM and UTAUT models and are not created directly from evidence from research with older people. In addition, there are many discrete constructs in the Almere model, however, people may have a positive attitude on one of these constructs and have a negative attitude on another. Thus, for respondents, the individual constructs may not be meaningful, and it might be a waste of time to measure them separately. Moreover, the consistency of the Almere questionnaire statements and constructs has not been verified.

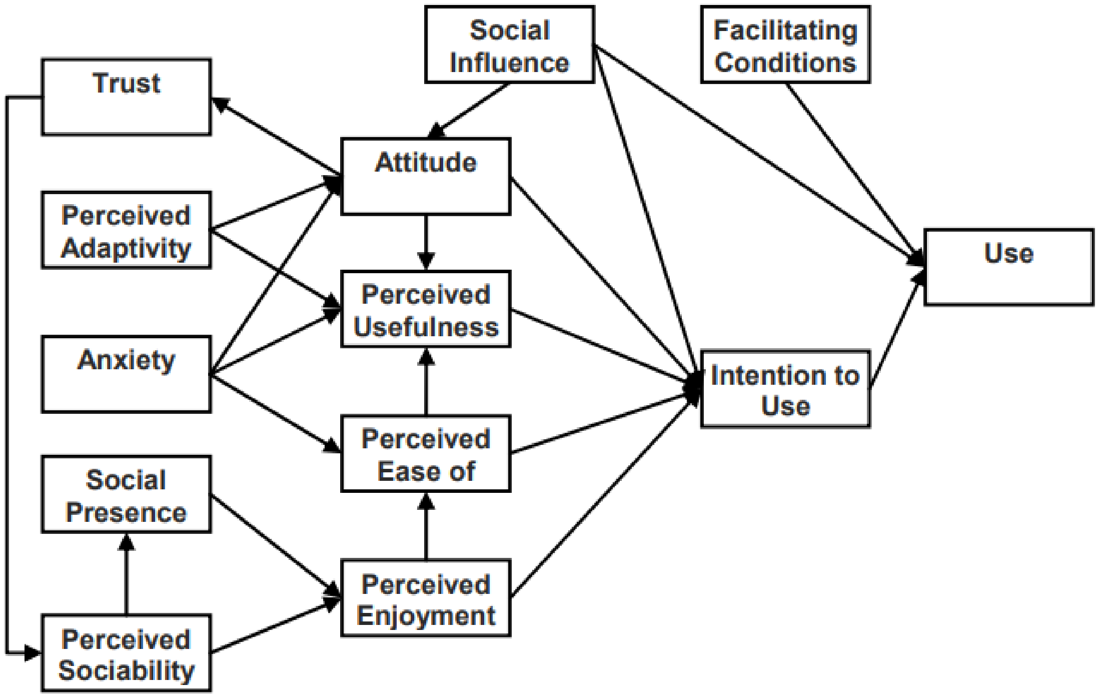


Figure 2.7: The interrelations of constructs in the Almere model (Source: Heerink, 2011)

Collectively, various qualitative and quantitative methods have been used to explore older people's attitudes toward technologies and robots. However, the most popular and widely used model in existing studies, TAM and UTAUT, is not focused on older people and robots.

STAM was developed particularly to assess older people's attitudes toward technology, and this model was proposed in the context of Chinese older people. The Almere model has been developed to assess older people's attitudes toward robots. However, the robots used in Heerink's study might be regarded as a very specific type of robot, assistive social agents. Thus, it is still not known whether it could be used for other robot types. In the circumstances, the fourth study of the research programme included using the Almere model questionnaire to assess older Chinese people's attitudes toward pet robots, and compare these with the results from the qualitative method to investigate whether the questionnaire confirmed the results from the from the interviews. In addition, this programme of research also investigated whether there is a more concise model of older people's attitudes to robots in comparison with the Almere model.

2.9.2 Older people's attitudes toward technologies

In recent years, there has been an increasing interest in older people's attitudes and acceptance of technology. Attitudes toward technology among older people are complex and multifaceted. Unlike a commonly held stereotype, many recent studies have found that older people have positive attitudes toward technologies. For example, some studies (e.g. Fausset et al., 2013) have suggested that older people viewing technologies as tools which can help them stay connected with loved ones, engage in leisure activities, and access health information. Some studies (e.g. Mitzner et al., 2010; Wang et al., 2019) explored older people's attitudes toward technologies in general, and others (e.g. Bickmore et al., 2005; Quan-Haase et al., 2018) explored their attitudes towards particular technologies, such as smartphones (e.g. Chan & Chen., 2016) and tablet computers (e.g. Vaportzis et al., 2017). The following section reviews the existing literature on older people's attitudes toward technologies in general first, and then reviews the literature on their attitudes toward particular technologies.

Studies that have investigated older people's attitudes toward technologies in general include Mitzner et al. (2010). 113 older American people aged from 65 to 85 participated in the study and took part in focus groups and then completed the Technology Experience Questionnaire. The results showed that participants used various technologies, such as microwaves, cellular phones, and television. Their positive attitudes outnumbered negative attitudes. The study also reported how their positive attitudes usually related to technologies which supported their activities, enhanced convenience, and included useful features, while their negative attitudes related to inconveniences, useless functions, and safety and reliability issues. This is a large sample study using both qualitative and quantitative methods, which helps us understand older people's technology use and attitudes. The only limitation in the study was that the older people were all from the USA; thus, the results do not represent older people from other cultural backgrounds.

Fausset et al. (2013) investigated older people’s perceptions of technology in their everyday lives with a daily diary method over four weeks. Six older American people (aged 55-84, 3 males, 3 females) participated in the study, they were asked to carry the notebook with them at all times so they could record any interactions with technologies. The study found that the older people used a wide range of technology to improve efficiency, make life easier, and communicate. The study also found that the older people held positive attitudes toward technologies, and that their children played an important role in affecting technology adoption and use. However, there were only six participants in the study, and they were all from the USA. The small sample size did not allow investigation of the attitudes of older people with different backgrounds such as different cultural backgrounds. Notwithstanding the relatively limited sample, this work offers valuable insights into older people’s perceptions and use of technology.

To identify barriers to older people's adopting technologies and digital platforms, Wang et al. (2019) investigated older American people’s barriers and facilitators to technology adoption, and their attitudes to privacy. 31 older American people (20 females, 11 males) aged between 67 and 94 participated in focus groups. The study found that low technology literacy can make technology adoption difficult, while an eagerness to learn, interest in co-design, and a desire to understand and control their data acted as facilitators. The study also found that privacy is important to older people, especially data privacy, and that they are willing to contribute to the design of technologies. Notwithstanding the relatively limited sample, in which the majority of participants were female, this work offers insights into older people’s attitudes toward technologies and digital platforms.

Several studies have reported older adults' use and acceptance of specific technologies. For example, Bickmore et al. (2005) examined the acceptance and usability of an animated conversational agent. Eight older American women participated in the study, aged between 62 to 82 years. They interacted with an animated conversational agent (an exercise advisor) for two months. Questionnaires and semi-structured interviews was conducted in the end of the study to explored their satisfaction, repetitiveness, informativeness, interestingness, liking, and trust. The result shows they held positive attitudes towards the agent. However, one limitation is that the data were collected at the end of the study; thus, the study does not show if the participants' attitudes have changed. Another limitation lies in the fact that all participants were all female and all American, no men participated in the study. Therefore, the results only reflect female older American people's acceptance and usability of an animated conversational agent.

Ma et al. (2016) explored older Chinese people's smartphone use and key factors influencing smartphone acceptance. 120 older Chinese people completed a questionnaire (modified from TAM and UTAUT) with the assistance of the researcher because their literacy levels are varied. The study found that older Chinese people generally accepted smartphones, but their use patterns differed based on demographic characteristics. The results showed that those who were younger, with higher education, non-widowed status, and relatively higher economic status, supported either by salary or family, were more inclined to embrace the use of smartphones. In addition, the study found that cost tolerance was the most important factor that would directly influence the intention of older Chinese people to use a smartphone. Moreover, facilitating conditions (UTAUT) were also very important in affecting older people's intention to use smartphones, and older people may need a better support to use smart technologies, such as proper training before the use of unfamiliar technologies. Despite the study only being conducted using a quantitative method, the large sample size provides the strong evidence to add to our understanding of older people's attitudes toward smartphones especially in the context of Chinese culture rather than Western culture.

To better understand older people's attitudes toward tablet computers, Vaportzis et al. (2017) investigated older British people's perceptions of tablet technology and barriers to interacting with tablet computers. They explored the perceived advantages and disadvantages of using tablet computers, as well as participants' level of familiarity and obstacles they encountered when interacting with tablet computers. 18 older people (15 female, 3 male) aged between 65 and 76 years participated in focus groups and interacted with tablet computers in the study. The study found that older people accepted and intended to use tablet computers. Thus, older British people hold both positive attitudes, but also some negative attitudes and concerns about using tablet computers. In terms of their positive attitudes to tablet computers, they mentioned the ability to access information, and their willingness to adopt the technology. Regarding the negative attitudes and concerns, they mentioned too much and too complex technology and negative features of tablets, their feelings of inadequacy in understanding technology, in comparison with younger generations, and lack of social interaction and communication. Although the study was based on a small sample of participants, and the majority of participants were female, it offers valuable insights into older people's attitudes toward using tablet computers.

Quan-Haase et al. (2018) interviewed 41 older Canadian people aged between 65 and 93, to investigated their attitudes to using digital media. The study found older Canadian people used computers, landline telephones, mobile phones (both basic and smart), and tablets in their daily life. They had varied attitudes toward using digital media. In terms of positive attitudes, participants mentioned that they can stay connected and learn new skills. Regarding negative attitudes, participants mentioned that digital media might overwhelm them or waste their time. Although the participants are only from Canada, the study adds to our understanding of older people's attitudes toward digital media use.

However, with the rapid development of science and technology, especially with the rapid development of AI, the technology products used by older people in their daily lives are no longer just computers and smartphones. Older people are now also likely to use technology products with AI technology. The technology use found in previous literature may not applicable to older people now. Furthermore, the majority of the previous studies were conducted in Western countries, and little is known about older Chinese people's technology use and attitudes. Therefore, the second study of the research programme explored older Chinese people's technology use in daily life and also assessed their attitudes toward new technologies that they have not used yet.

2.9.3 Older people’s attitudes toward robots

Robots are increasingly used in various fields including healthcare, transportation, manufacturing, and entertainment. The use of robots is expected to continue to grow as technology advances, and their potential benefits are realized. Robots have the potential to improve efficiency, productivity, and quality of life. In the context of aging, robots can also provide support and assistance to older people, and these are now being designed to assist older people in their daily lives. Although robots have the potential to improve the quality of life of older people, their acceptance and adoption among older people remains a critical issue. The acceptance of robots by older people is not guaranteed, as their attitudes towards robots may be influenced by various factors such as their cultural background, personality, experiences, and expectations. Therefore, it is important to understand older people's attitudes towards robots to develop robotic technologies that meet their needs and preferences.

There is a considerable body of research of people’s attitudes towards robots. Naneva et al. (2020) reviewed 97 studies about people’s attitudes toward social robots, their levels of trust, anxiety, and acceptance about them, along with identifying factors associated with these perceptions. The results indicate a generally positive inclination towards social robots, suggesting a willingness to engage with them. Another recent study reviewed 50 studies about people’s acceptance of humanoid robots (Moberg & Kahn, 20222)., It assessed the diverse categories of robots used in each study, participants' roles, issues of cross-cultural acceptance, and the methodologies and technologies since the turn of the century. The study underscores the necessity of people’s acceptance of, considering factors such as user age, gender, cultural background, and familiarity with contemporary technology, due to the varying attitudes toward robots with human characteristics.

In addition, Gnambs and Appel (2019) investigated whether attitudes toward robots have changed over time and explored potential factors influencing these changes in Europe (in 27 European countries, 80396 participants who aged between 15 and 99 years participated in interviews, 55% were female). The study showed that attitudes toward robots have indeed become less favorable in recent years, attitudes towards robots assisting at work showed the strongest negative trend. This was potentially due to increased exposure to media reports about the negative consequences of automation. Additionally, the study found that women with lower levels of education held more negative evaluations of robots and that countries with a higher proportion of older residents expressed more positive attitudes towards robots.

A recent study was conducted to investigate the various factors influencing the acceptance of social robots among potential users in Greece (Chatzoglou et al., 2023). 347 participants (aged between 18 and 24, 59.9% were female) completed the questionnaire that examines five main factors (hedonic attitudes, utilitarian attitudes, normative beliefs, control beliefs, and personality traits) that may affect people's intention to use social robots. The study found that normative beliefs and utilitarian and hedonic attitudes have a positive impact on people's intention to use social robots. However, there was also evidence suggesting that control beliefs have a negative impact on this intention. Therefore, the study suggested that prospective users are influenced not just by general societal attitudes, perceptions, and prejudices towards robots, but also by the functional benefits offered by social robots.

To date, a number of studies have begun to examine older people's attitudes toward robots. The literature on older adults' attitudes towards robots is relatively new but growing. Older people's attitudes towards robots have been investigated in various contexts (e.g. healthcare, domestic settings, and entertainment) with different robot types (e.g. companion pet robots and task-oriented robots). The following sections review the existing literature on older people's attitudes toward companion pet robots and task-oriented robots.

2.9.3.1 Older people's attitudes toward companion pet robots

As mentioned above, companion robots developed for older people are mostly in the form of pets. Companion pet robots are designed to provide companionship and emotional support to older people. These robots are programmed to engage in conversation, play games, and perform various tasks to enhance the well-being of their users. The use of companion pet robots is on the rise among older people as a way to tackle behavioural and psychological symptoms of dementia, and to provide companionship in aged care centres and their homes. A number of studies have investigated older people's attitudes toward companion robots. However, there is limited information available regarding the use of companion pet robots by healthy older people outside institutional settings.

Lazar et al. (2016) explored older people's expectations of robotic pets. 41 older American people aged from 61 to 92 participated in focus groups. They were shown six robotic pets, each robot was passed around to participants, who were told the features of each robot; then, participants discussed their perception of robotic pets. The study found that older people wanted comfort and companionship from a robotic pet. They wanted robotic pets that can offer social amusement and enable opportunities for social engagement rather than reducing feelings of loneliness and social isolation. Finally, the participants expressed a desire for more than just a robot that provided practical help without expecting anything in return. They preferred the idea of looking after robotic pets as a way of expressing nurturance and building a relationship.

McGlynn et al. (2017) investigated older American people's attitudes toward the companion pet robot Paro. 30 independently living older American people aged 67 to 80 years (15 men, 15 women) participated in the study. The study explored older people's attitudes towards the companion pet robot using quantitative and qualitative methods, which included two constructs of "Perceived Ease of Use" and "Perceived Usefulness" (TAM), Positive affect negative affect schedule, and semi-structured interviews. They completed questionnaires and were interviewed both before and after interacting with the robot. The study found that they had positive attitudes towards Paro. But there were no pre-post interaction differences on measures. They thought it would be easy to use, and expressed their intention to use the robot. Although the sample are only from America, the study helps us to understand older people's perception of companion robot Paro.

Bradwell et al. (2019) investigated 17 British older people's (aged 60 – 99, 5 males, 12 females) preferences for companion robots. Participants interacted with eight companion robots (shaped as animals), and then participated in focus groups on perceptions of companion robot design. Participants expressed a preference for interactive animals that were familiar and realistic, with a soft and furry appearance, while unfamiliar forms were seen as making them feel infantilized. The study also found that older people want to talk with companion robots, and they responded positively to life-like features, eye contact, robot personalization, and the robot's ability to obey commands. A limitation of this study is that the majority of older participants were women, and the results of the study may be more representative of the views of older women.

Huang and Huang (2020) investigated older Chinese people's attitudes toward companion robots, and how attitudes were influenced by individual factors, such as educational and professional backgrounds. Semi-structured interviews and the Almere Model questionnaire (two constructs) were used to explore participants' attitudes. 6 older Chinese people (4 males, 2 females, aged from 66 to 75) participated in semi-structured interviews to provide some basis and reference for the design of the questionnaire (two constructs from the Almere model were used in the study: attitude and perceived usefulness). 148 older Chinese people (87 males, 61 females, the age is mainly between 60 and 69 years old, with 21 over 80 years old) completed the Almere Model questionnaire. The study found that older Chinese people had varied attitudes toward companion robots. Older people living with family members, had usage experience of technology products, with high education and medical professional background had more positive attitudes of companion robots, while the older people without usage experience of technology products, with primary school education, tended to have negative attitudes towards companion robots (although they did not specify any particular robots). Although participants did not interact with any robots, the researcher just described the concept of a companion robot, the large sample size can provide more reliable data for understanding older Chinese people's attitudes toward companion robots.

A recent study by van Orden et al. (2022) reported a programme which distributed robots to older people during the COVID-19 pandemic. The study investigated 303 older American people's satisfaction with this programme and attitudes toward pet robots, all the participants had interacted with pet robots. The study investigated older people's attitudes through phone interviews, as the study was conducted during the COVID-19 pandemic. The result show that the older American people had high satisfaction with the programme, although not specifically with the robot themselves. They held positive attitudes toward companion pet robots, especially for reducing loneliness and their benefits in alleviating symptoms of dementia.

Guerra et al. (2022) reviewed and summarized older people's expectations of companion pet robots in a metareview of 10 studies, published between 2016 and 2020. Three themes emerged from the analysis: companion pet robots are like real pets, but with less maintenance; they perform multiple functions, with customizability; they are facilitators of interactions without promoting social stigma. In terms of the theme of being like real pets, but with less maintenance, older people highlight both appearance and interaction. They emphasize the importance of using materials like fur instead of plastic to achieve this effect, and they also stress the need for flexibility to enable cuddling and hugging with a friendly facial expression. Although they favour a robot companion with a lifelike pet appearance, this robot should need less maintenance (both in effort and demands) compared to a real pet such as a dog. Companion pet robots should be an appropriate size, easy to wash, and have an affordable price. In terms of the theme of performing multiple functions, with customizability, older people want companion pet robots that can perform varied functions, such as health monitoring and reminder functions., In addition, robots should be customizable according to older people’s different needs. In terms of the theme of being facilitators of interactions without promoting social stigma, older people think that companion pet robots hold greater suitability and benefits for particular demographics, such as individuals dealing with mental and physical challenges. Thus, they worried that having a companion robot could reinforce negative stereotypes or lead to older adults being treated as if they were infants.

From the existing research on the attitudes of healthy older people living independently toward companion pet robots, their attitudes have been generally positive. Their attitudes are influenced by various factors, including their prior experience of using technologies, living situation, and their educational background.

2.8.3.2 Older people’s attitudes toward task-oriented robots

Task-oriented robots are designed to perform specific tasks, such as cleaning the house or reminder of daily routine schedule, in order to assist older people with their daily activities. As the population of older people continues to grow, the use of task-oriented robots has become increasingly popular. A number of studies have begun to examine older people’s attitudes towards task-oriented robots.

Ezer et al. (2009) explored older and young people's expectations and acceptance of domestic robots (this is the same as what I meant by task-oriented robots) and examined the differences between them. 117 older American people (aged 65-86) and 60 young people (aged 18-25) completed the TAM questionnaire (Section 2.8.1). The results showed that the older people accepted robots and expect robots as “performance-directed machines” (this is the same as what I mean by task-oriented robots). They also perceived robots as being useful and easy-to-use, but they held neutral attitudes about their intention to use robots. The study also found that the two constructs of “usefulness” and “ease of use” (TAM) as found to be a robust predictor of robot acceptance, and technology experience was found to account for the variations in robot acceptance due to age. Although the study claimed that the constructs of TAM could as a predictor, but actual robots use was not measured. This study explored participants' perceptions about robots according to their thoughts about having a robot in their home and they did not interact with any robots or get any information about robots from the researchers.

In a study investigating older people’s attitudes toward a human-like socially assistive robot, McColl and Nejat (2013) who investigated older adults’ acceptance and attitudes towards the robot Brian 2.1 during mealtimes. Their study was conducted in a Canada elderly care facility, with 8 older people aged between 82 to 93, who had a meal with the robot Brian 2.1, and then completed the questionnaire (the questionnaire included 10 constructs adapted from the Almere technology acceptance model). The participants had positive attitudes towards robots and they found interactions with the robot to be enjoyable. All the participants found the robot's encouraging behaviours helpful. In addition, the most-liked characteristics of the robot in a meal environment were the robot’s human-like voice, followed by the companionship the robot provided by just being there, followed by the robot expressing different emotions through facial expressions and different tones of voice, and finally the robot's life-like appearance and demeanour. Although the study involved only a small number of participants, this innovative study showed the effectiveness of the robot as a social motivator during mealtimes for older people. These results were similar to those from Louie et al. (2014) who found that older adults had positive attitudes toward the robot and its intended applications. 46 older Canadian people participated in the study, 37 females and 9 males. The socially assistive robot Brian 2.1 was chosen to interact with participants in two tasks, a Memory Card Game and a Restaurant Finder. After that, a robot acceptance questionnaire (the questionnaire was adapted from the Almere technology acceptance model) was used to explore older people’s attitudes towards the robot.

Broadbent et al. (2014) investigated whether healthcare robots were feasible and acceptable by older people and assessed their potential impact on medication adherence, quality of life, and depression. This study was conducted in New Zealand with 29 older people (aged between 72 and 94, 14 males and 15 females) who lived independently. Participants used robots for 6 weeks and had a non-robot 6-week control period. The robots in the study did a range of tasks, including medication reminders, memory games, entertainment, Skype calls, and blood pressure monitoring. Interviews were conducted to investigate participants' attitudes and experiences with the robots. In addition, questionnaires were used to measure participants' medication adherence (Medication Adherence Report Scale), quality of life (SF-12), and depression (Geriatric Depression Scale). In addition, two questionnaires were used to assess participants' attitudes toward the robots (Robot Attitudes Scale, Mind Perception Questionnaire). The results showed robots were feasible and acceptable, with many participants noting that they found the robots useful and friendly. However, the robots had no significant impact on adherence, depression, or quality of life. Although the number of participants in this study was not large, both quantitative and qualitative research methods were used in the study to help understand older people's attitudes towards the robots to assist them in daily life. In addition, participants had experience interacting with robots for six weeks, which increases the ecological validity of the study.

Smarr et al. (2014) investigated older people's attitudes and preferences toward domestic robots (the same as what I mean by task-oriented robots). 21 older Americans (15 females, 6 males) who live independently aged between 65 - 93 years old watched a video that showed the robot, a Willow Garage's Personal Robot, its physical characteristics, capabilities, and the various tasks the robot could accomplish. They then participated in group interviews and completed the Robot Opinion Questionnaire The study found that the older people showed generally positive acceptance of robots for assistance in their homes. The older people's preferences for the tasks that robots could do will be discussed later in this section. A limitation of the study is the majority of participants are female; thus, the results largely represent older women's attitudes.

Wu et al. (2016) investigated older French people's (with mild cognitive impairments) attitudes towards an assistive robot. The study involved both focus groups and semi-structured individual interviews. Five older people (aged 63 to 88, 4 females, 1 male) participated in the focus groups, and 15 older people (aged 64 to 87, 12 females, 3 males) participated in the interviews. Both focus groups and individual interviews addressed problems and difficulties experienced in the participants daily lives and the strategies used to compensate for them, as well as technologies to enhance their well-being. The focus group discussion was chosen for preliminary data collection, individual semi-structured interviews were conducted to delve deeper into the participants' thoughts and perspectives. Almost all participants reported cognitive difficulties, but they did not think they needed a robot’s help. Some of them thought robots can assist or substitute for humans in doing certain tasks, while others mentioned robots as something frightening, potentially dangerous, with an imposing bearing. Thus, the results show that older French people did not need or want a robot for the moment. This study demonstrates the negative attitudes of older people towards robots and explores the reasons behind them. The study also had some limitations. The majority of the participants were female. Thus, the results represent French women’s perceptions of robots. In addition, participants only received information about robots from the researchers’ oral descriptions without showing pictures or videos about robots. Thus, the attitudes of older people toward robots may not be representative.

Bedaf et al. (2018) explored different stakeholders’ perceptions of the use of service robots (this is the same as what I meant by task-oriented robots) for older people, the stakeholders included older people, informal caregivers (older people’s children), and professional caregivers. 10 older Dutch people aged from 62 to 93 years old participated in the study. Participants interacted with a Care-O-bot robot, then completed a questionnaire to explore their experience and took part in semi-structured interviews to reflect on their interaction with the robot and discuss its potential functions in everyday life. The study found that older people were more willing to accept the robot than their caregivers and family members. In addition, the study also investigated older people’s expectations of robots, which will be discussed later in this section. Although the sample size of older people in the study is small, all participants interacted with the robots in the study, which increases the ecological validity of the study.

Backonja et al. (2018) investigated young, middle aged, and older people’s comfort and attitudes toward robots in the United States. Although the main purpose of the study was to compare the differences in attitudes toward robots between different age groups, the study offers some insight into older people’s attitudes toward robots. 102 older people participated in the study, aged 65 to 98 years. They completed a questionnaire that included the Negative Attitudes Toward Robots Scale (NARS) to assess attitudes toward interactions with robots and two additional questions to investigate their perceptions of the social impact of robots and comfort with situations involving robots respectively (taken or modified from the European Commission's Autonomous System 2015 Report). The study found that older people hold neutral attitudes towards robots. In addition, participants agreed that robots are good for society because they are helpful and necessary; they also felt comfortable with robots completing some tasks, such as assisting people at work, but they felt uncomfortable with robots undertaking some tasks, such as robots caring for children. However, the majority of participants did not use robots, and many of them had no knowledge about robots, and participants did not get information about robots or interact with a robot as part of the study. In these circumstances, the attitudes of older people toward robots may be not representative.

A recent study by Park et al. (2019) involved independently living older adults' needs and attitudes toward robots to assist with daily living. The study used both quantitative and qualitative methods in two separate phases. The first phase is to investigate participants' acceptance of and needs for robot technology. The Visual Analogue Scale (VAS) was used to measure 8 Connected Active Space (CAS) needs; this included rating functions such as early detection of emergency situations, recording food intake, locating objects, assisting with mobility, recording memories, recalling memories, and logging daily activities; these were rated on a scale from "never need" to "very much need". The CAS acceptance was also measured by VAS, ranging from "never accept" to "very much accept". 234 Korean participants aged 65 to 96 (over 70% female) completed the Visual Analogue Scale. The results showed their need for and acceptance of robot services were highest to assist in daily living tasks. In the second phase, participants took part in focus groups to discuss their opinions about robots. The results showed a "mismatch between desires and functional capacity" was the core characteristic of living as an older person, and "being a friend and helper" was the most desired characteristic of a robot.

With the development of technology, some small robotic devices (task-oriented table robots) and related devices such as intelligent voice assistants (IVAs) such as Alexa from Amazon and Siri from Apple are now used by older people in daily life. However, some older people try out robotic devices but then do not continue using them. Trajkova and Martin-Hammond (2020) investigated the reasons older people stop using IVAs. 38 older American people (aged 67-97 years) who used an Echo (an IVA from Amazon) participated in focus groups. The study found that reasons for not continuing to use the ECHO included difficulties finding valuable uses, beliefs associated with loss of independence and IVA use, or challenges with use in shared spaces. A limitation of this study is that all the participants were users of only one IVA, the Echo and not a range of IVAs; thus, the results may not be representative of older people's negative attitudes toward IVAs in general.

Heerink and colleagues did a series of studies to explore older Dutch people's attitudes toward the assistive social agent technology (the same as what I mean by task-oriented robots) and factors influencing older people's acceptance of them. To investigate the influence of the social abilities of robots on older people's attitude towards and acceptance of them, 40 older Dutch people (aged 65-89; 18 males, 22 females) participated in one of their studies (Heerink et al., 2006). They were observed in 5-minute interaction sessions in which participants were asked to perform the three simple tasks with an iCat robot: setting the alarm, giving directions to the nearest supermarket, and giving the weather forecast for tomorrow. There were two conditions, in one the robot was more socially adept, and used the participant's name; the other was a more impersonal control condition. After the interaction, participants were asked questions about their acceptance of the robot that were adapted from the UTAUT questionnaire. The results show that participants who engaged with the robot's more socially adept condition experienced greater comfort and demonstrated increased expressiveness when interacting with it.

A further study (Heerink et al., 2008) explored enjoyment as a possible factor influencing acceptance of robotic technology by older people. 30 older Dutch people (aged 65- 94, 22 females, 8 males) played with an iCat robot for around 3 minutes without any task requirements. They then completed a questionnaire to measure their enjoyment. Finally, the iCat robot was left in the public area of the elderly care institution to see whether participants would interact with the iCat later. The results show that perceived enjoyment has an effect on the intention to use robots, 23 of the 30 test session participants did use the system later. Although Heerink and colleagues have conducted a series of studies about older people's attitudes towards robots, these studies are now over ten years old. With the development of technologies and their widespread application, the attitudes of older people towards robots ten years ago may not represent the attitudes of older people today.

Many studies have investigated the expectations of older people about task-oriented robots when they explored older people’s attitudes (e.g. Smarr et al., 2014; Bedaf et al., 2018). In addition, also have many studies particular focused on older people’s expectations of using robots, covering aspects such as robots’ functionality and interaction methods (e.g. Frennert et al., 2013; Samaddar & Petrie (2020).

Frennert and her colleagues have also conducted a number of studies to investigate older Swedish people’s expectations of and attitudes toward task-oriented robots. Frennert et al. (2012) investigated older people's attitudes and perceptions of having their own robot. 14 older Sweden people (aged 65-86, 7 males, 7 females) participated in a workshop, and then answered a questionnaire to validate the finding from the workshop. They were shown different robot images, and discussed their ideas and opinions. In addition, they were given Attention Cards, which visualize scenarios in which robots could be used in different aspects of daily life. Then, participants discussed their attitudes and perceptions of physical and personal space in regards to a robot again. The results show that the robot's functionality holds greater importance than its appearance for older people and that the level of usefulness plays a key role in the willingness to accept a robot. Assistive robots were viewed as non-intrusive, and having them in bathrooms and bedrooms was seen as acceptable. Overall, the older people believed that it is crucial to stay informed about advancements in technology. These findings suggest that older people are open to experimenting with assistive robots as long as they see them as beneficial.

In 2013, Frennert et al. conducted a mixed methods study (focus groups, a workshop, a questionnaire, and interviews) to investigate 88 older Swedish people's expectations about robots, addressing five aspects: functionality, safety, operation, mutual care, and appearance. Participants expressed a number of expectations in relation to each aspect. For example, in relation to safety, participants want robots which can call for help if something happens. In general, the results show that older people’s perceptions and expectations concerning robots are multi-dimensional and contradictory. This complexity is evident in the contrast between the advantages of using robots to assist older people, aiding or performing tasks that they may struggle with, and the emotions of ambivalence and adaptability, and the disparities within relationships that come with these advantages. In addition, participants thought that robots might be “good for others but not themselves”, “good as a machine not a friend”.

Frennert and Östlund (2015) conducted a further study to explored how older people adopt, use and make sense of robotic vacuum cleaners in their daily lives. 10 older people (8 females, 2 males) participated in the study over 13 months and were interviewed four times during that period. The first round of interviews took place before the robotic vacuum cleaner was installed and investigated participants' expectations of robotic vacuum cleaners as well as their cleaning habits. The second round of interviews took place after a week after the vacuum cleaner was installed and explored the initial experience and attitude toward the robotic vacuum cleaners, as well as observing the actual usage and maintenance of the robotic vacuum cleaner. The third and fourth rounds of interviews to place six months and 13 months after the vacuum cleaner was installed, respectively, and investigated the participants' cleaning habits and robotic vacuum cleaning practice and experience. The study also included two quetionnaires (pre-instalment of the robots and 13 months after the instalment), the WHO Well Being Index (ref) and the Falls Efficacy Scale International (ref) to evaluate whether the participants' physical and psychological capability affected their technology adoption process. The results show that older people displayed interest in embracing technological advancements such as robotic vacuum cleaners, as they perceived these innovations as advantageous for effectively managing and arranging their daily tasks. Robotic vacuum cleaners lead to a transformation in their daily routines, they tend to use the robots as a complement and not as a replacement for human cleaners or ordinary vacuuming at the beginning of the study, then the robotic vacuum cleaner had become incorporated in everyday practice in the end of the study. Participants adopted robotic vacuum cleaners not just because they were functional and useful, but also because they are a means by which older people can cope with everyday life and conserve physical energy for other activities.

To explore older people's perception of robots in health and care of older people, Frennert and Östlund (2018) conducted focus groups with 31 older people (aged 64 to 87, 55% females, 45% males) As part of the focus group, participants watched videos which presented different robot applications in health and care of older people. They were asked to describe and design their ideal robot and explain what they would like it to do. The study summarized participants' perceptions of robots into four themes: the potential of using robots in health and care of older people; concerns; pre-conditions; and barriers to using robots. Regarding the theme of the potential of using robots, participants thought that robots might decrease health and care costs, improve working conditions for healthcare and care professionals, increase patient service, increase quality of care, patient independence and integrity. 24/7 service and assistance. Regarding the theme of concerns of using robots, participants worried about mechanical care, the “over-reliance” of robots in health and care of older people, reliability, vulnerability and dependency, and safety. Regarding the theme of pre-conditions, participants indicated that these would relate to their needs and purpose, technology interests, finances, and availability. The final theme of barriers to using robots included worries about the word ”robot”, costs, size and appearance, reliability, question of responsibility, practical handling and usability.

To better understand the way that older people would prefer to interact with robots, Biswas et al. (2020) compared the way of young and older people prefer to interact with robots. 18 older people aged over 65 participated and watched six videos showing older people interacting with robots in different scenarios. They then completed questionnaires (12 questions), which investigating their choices of multimodal interface in such situations. The questionnaire includes two aspect, which are videos of human–robot interaction (six questions) and their views on robots and technology (six questions). Older people showed a preference for speech-based interaction with robots over tablet-based interaction.

Samaddar and Petrie (2020) investigated older British people’s expectations of robots, and reassessed whether current research and development is addressing their needs. 22 older British people (aged 66-82, 12 males, 12 females) took part in interviews. Participants were asked about what they would want from a robot in their home. They were shown photographs of five different types of robots and other support agents (large humanoid robots, voice agents, robot pets, tabletop robots, virtual agents). Six main themes emerged: “Forgetting Things”, “Dexterity Issues and Help with Mobility”, “Help with Cooking”, “Finding and Fetching Objects”, and “Games and Exercise”. The results show there are gaps between the current research and older people’s needs. In addition, participants were generally intimated by humanoid robots and are concerned about their privacy with voice agents but do not have a particular preference of robot types otherwise, such as pet robots and humanoid robots. The study only explored older British people’s expectations of robots, which might not be representative of older people with other cultural backgrounds. It is worth further investigating to see if there have any differences.

In addition to investigating some specific expectations of older people for robots, the previous research also investigates what roles older people hope robots can play in their lives. In the paper discussed by Smarr et al. (2014) about older American people's attitudes toward task-oriented robots, the study also explored older American people's preference for robots to assist them in daily life. The study found that older American people expressed a preference for robot assistance over human assistance for tasks related to chores, object manipulation, and managing information. In addition, Bedaf et al. (2018) found that older people want robots to perform more intricate tasks. The study suggested that a future robot must be able to perform complex tasks tailored to the user's preferences, which would necessitate the robot to be highly adaptable and intelligent, akin to human caregiving, comparable to the level of care provided by a human caregiver.

Considering all of this evidence, it seems that older people hold positive or neutral attitudes toward companion pet robots; they expect that companion pet robots should look like real animals and communicate with them; despite the fact that some studies show older people have negative attitudes toward task-oriented robots, the majority of existing studies show older people hold positive or neutral attitudes toward task-oriented robots, and they have various expectations of robots which cover all daily aspects of doing physical task and cognitive task, such as doing housework and reminding daily routine schedule, and they want such robots to do more complex tasks and act as a caregiver.

However, existing studies about companion pet robots were usually conducted in nursing home institutions, and much less is known about companion pet robots being used outside of institutional settings. In addition, many studies are in the context of conditions associated with aging, such as Alzheimer's disease, rather than in the context of independent living. Therefore, very little is known about the attitudes of healthy older people living independently toward companion pet robots. Existing studies of older people's attitudes toward robots also usually focus on a single type of robot; thus, older people's attitudes toward a range of different robot types have not been investigated. Finally, most studies have been conducted in North America and Europe, and few studies have explored older people's attitudes in other cultural backgrounds. Therefore, the third study of this research programme will explore older Chinese people's attitudes, preferences, and expectations toward different robot types. The fourth study will examine older Chinese people's attitudes toward companion pet robots as companions and assisting in daily life.

2.10 Conclusions

This literature review explored different definitions of older people and proposed one that will be used in this thesis. It also presented information about the demographics of aging and the problems of old age in China. Then, the review presented research on sexism and ageism in China, and reviewed previous studies on young people's attitudes toward older people, and young people's attitudes toward older people as technology users. Although there have been many studies examining young people's attitudes toward older people in general, few studies have investigated young people's attitudes toward older people as technology users. Previous research has established that young people generally hold negative attitudes toward older people using technology. In addition, existing research on young people's attitudes towards older people as technology users has focused on young Europeans. As far as I am aware, no previous study has investigated young people's attitudes with other cultural backgrounds.

In addition, this literature review presented an overview of technologies and robots currently being developed for older people. Currently, technology for older people mainly focuses on three aspects: assistive technologies, healthcare technologies, and information and communications technologies. Robots developed for older people are mainly oriented to two areas, companionship and task-oriented.

The literature review covered previous research about older people's technology use to identify the technologies used in their daily lives and their attitudes toward them. It also covered previous research about older people's attitudes and expectations toward companion pet robots and task-oriented robots. In terms to older people's attitudes toward companion pet robots, results from several studies suggest that older people tend to hold positive attitudes toward companion pet robots. In addition, older people have many expectations for companion pet robots, such as hoping they will be like real pets and able to talk to people. Regarding older people's attitudes toward task-oriented robots, although some studies show that older people tend to hold negative attitudes toward this type of robot, the majority of studies show that older people hold positive attitudes toward them and accept the idea of using them in daily life. Moreover, their expectations about the use of task-oriented robots to assist them covers all aspects of daily life. Generally, they want robots to perform more complex tasks as human caregivers do.

Overall these studies provide important insights into older people's attitudes and expectations of robots. However, previous research has been oriented toward examining older people's attitudes toward a single robot type, and few studies compared older people's attitudes toward different robot types. In addition, the majority of previous studies were conducted in North America and Europe, and little attention has been paid to older people with other cultural backgrounds. Further, limited research has investigated companion pet robots among healthy older adults outside of institutional settings, and most studies have investigated older people living in contexts such as nursing homes. In addition, most of the previous investigations of older people's attitudes towards companion pet robots have been mostly in the context of caring for older people with cognitive problems, such as Alzheimer’s disease, rather than in the context of caring for healthy older people.

This literature review also considered the frameworks and methods used to investigate older people's attitudes toward technology and robots. TAM and UTAUT models have the most popular frameworks and had been widely used in previous studies to investigate older people's attitudes toward older people. However, neither model is aimed at understanding the attitudes specifically of older people, nor is are they aimed at understanding attitudes to robots. However, the Almere model was specifically developed to investigate older people's attitudes toward assistive social agents, although it has not been validated with older people's attitudes toward other types of robots. Thus, the Almere model is used as part of my fourth study to investigate older Chinese people’s attitudes toward pet robots to investigate whether results from the Almere model questionnaire agree with the results from interviews with older people.

Therefore, the first study of this programme of research investigated young Chinese technologists' attitudes toward older people as technology users, and compare these perceptions with the perceptions of older Chinese people. The second study explored older Chinese people's technology use in daily life, and their attitudes toward technologies and robots. The third study examined older Chinese people's attitudes, preferences, and expectations about three different robot types. The fourth and final study investigated older Chinese people's attitudes and expectations specifically of a pet robot for companionship and daily living assistance.

Chapter 3: Study: 1 Ageism and sexism amongst young technologists and older people in China

3.1 Introduction

Older people increasingly need and want to use technologies to assist them in living more independent and productive lives. But it is largely younger people who design and develop these technologies, so it is important that they are able to understand and empathize with the needs and wishes of older people. Yet it is well-known that young people in European countries tend to have negative attitudes and beliefs about older people (Ayalon, 2014), although there is a much stronger tradition of respect for older people in China (Sung, 2001; Vauclair, et al., 2017). There is also a tendency to believe that women are less likely to use and less expert about technology (Reilly, et al., 2017). Finally, there is often a “double standard” in attitudes and beliefs, with older women being more negatively viewed than older men (Lin & Boldero, 2010).

Researching this topic with young British computer science students (who were very predominantly male), Petrie (2018) found that they thought that older people were less likely to use a range of digital technologies (desktop computers, laptop computers and smartphones) and less likely to be expert in using them. While she found no difference in beliefs that women would use these technologies less than men, there was a difference in beliefs about expertise, with women perceived as being less expert than men. However, she found no evidence of a “double discrimination” against older women being seen as less likely to use these technologies or less expert with them than the other groups.

The current research extended Petrie’s work to investigate young technology students and workers in China and also investigated the attitudes of older people about the use and expertise in technology. China now has a very large and rapidly growing older population. Thus it is vitally important that young technologists in China who develop for older people have positive and accurate views of their target audience. The first step towards that goal is to understand what their current views are. Therefore, there are two primary aims of this study: 1. To investigate whether the young people, as current and future designers and developers of technologies for older people, have ageist and sexist attitudes about older people as users of technology. 2. To ascertain whether their attitudes differ from those of older people.

The study will investigate the following research questions:

RQ1 When do Chinese people think old age starts?

RQ1a) What is the minimum age that young Chinese technologists perceive old age to start?

RQ1b) What is the minimum age that older Chinese people perceive old age to start?

RQ1c) Is there a difference between young Chinese technologists and older Chinese people in their perception of the minimum age when old age starts?

RQ 1d) Is there a difference between young men and women Chinese technologists in their perception of the minimum age when old age starts?

RQ 1e) Is there a difference between older Chinese men and women in their perception of the minimum age when old age starts?

RQ2 What are the attitudes of Chinese people to the use of digital technologies (desktop computers, laptop computers and smartphones) by young and old people?

RQ2a) Is there a difference in young Chinese technologists' attitudes to older and younger people as users of digital technologies?

RQ 2b) Is there a difference in older Chinese people's attitudes to older and younger people as users of digital technologies?

RQ2c) Is there a difference between young Chinese technologists and older Chinese people in their attitudes to older and younger people as users of digital technologies?

RQ2d) Is there a difference between young men and women Chinese technologists in their attitudes to older and younger people as users of digital technologies?

RQ2e) Is there a difference between older Chinese men and women in their attitudes to older and younger people as users of digital technologies?

RQ3 What are the attitudes of Chinese people to the expertise of young and old people in relation to digital technologies?

RQ3a) Is there a difference in young Chinese technologists' attitudes to older and younger people as experts in digital technologies?

RQ3b) Is there a difference in older Chinese people’s attitudes to older and younger people as experts in digital technologies?

RQ3c) Is there a difference between young Chinese technologists and older Chinese people in their attitudes to older and younger people as experts in digital technologies?

RQ3d) Is there a difference between young men and women Chinese technologists in their attitudes to older and younger people as experts in digital technologies?

RQ3e) Is there a difference between older Chinese men and women in their attitudes to older and younger people as experts in digital technologies?

RQ4 What are the attitudes of Chinese people to the use of digital technologies by women and men?

RQ4a) Is there a difference in young Chinese technologists’ attitudes to men and women as users of digital technologies?

RQ4b) Is there a difference in older Chinese people’s attitudes to men and women as users of digital technologies?

RQ4c) Is there a difference between young Chinese technologists and older Chinese people in their attitudes to men and women as users of digital technologies?

RQ4d) Is there a difference between young men and women Chinese technologists in their attitudes to men and women as users of digital technologies?

RQ4e) Is there a difference between older Chinese men and women in their attitudes to men and women as users of digital technologies?

RQ5 What are the attitudes of Chinese people to the expertise of women and men in relation to digital technologies?

RQ5a) Is there a difference in young Chinese technologists’ attitudes to men and women as experts in digital technologies?

RQ5b) Is there a difference in older Chinese people's attitudes to men and women as experts in digital technologies?

RQ5c) Is there a difference between young Chinese technologists and older Chinese people in their attitudes to men and women as experts in digital technologies?

RQ5d) Is there a difference between young men and women Chinese technologists in their attitudes to men and women as experts in digital technologies?

RQ5e) Is there a difference between older Chinese men and women in their attitudes to men and women as experts in digital technologies?

RQ6 Is there a "double standard" by Chinese people about technology use and expertise amongst older women?

RQ6a) Is there a difference in young Chinese technologists in their attitudes to older women as users of digital technologies in comparison to older and younger men and younger women?

RQ6b) Is there a difference in older Chinese people in their attitudes to older women as users of digital technologies in comparison to older and younger men and younger women?

RQ6c) Is there a difference in young Chinese technologists in their attitudes to older women in their expertise with digital technologies in comparison to older and younger men and younger women?

RQ6d) Is there a difference in older Chinese people in their attitudes to older women as in their expertise digital technologies in comparison to older and younger men and younger women?

RQ6e) Is there a difference between young Chinese technologists and older Chinese people in their attitudes to older women as users of digital technologies?

RQ6f) Is there a difference between young Chinese technologists and older Chinese people in their attitudes to older women as experts in digital technologies?

RQ6g) Is there a difference between young men and women Chinese technologists in their attitudes to older women as users of digital technologies?

RQ6h) Is there a difference between young men and women Chinese technologists in their attitudes to older women as experts in digital technologies?

RQ6i) Is there a difference between older Chinese men and women in their attitudes to older women as users of digital technologies?

RQ6j) Is there a difference between older Chinese men and women in their attitudes to older women as experts in digital technologies?

3.2 Method

3.2.1 Design

This study investigated the perceptions of ageism and sexism in relation to the use of and expertise with digital technologies amongst Chinese participants. Two groups of Chinese participants were included: young Chinese technologists and older Chinese people. The young Chinese technologists were university students studying technology-related subjects and young Chinese people already working in technology-related industries (henceforth "young technologists). The criterion for "young", as well was to be between the ages of 18 and 35.

As discussed in the Literature review (see Chapter 2, section 2.2), the definition of "older" people differs between countries and institutions. Some countries and institutions define older people as those over 60, while others use a definition of over 65. This study used the United Nations' definition as those over 60 years old[12]. In addition, the young Chinese participants in this study on average thought that people over 60 years are older people (see section 3.4.1.1), giving further justification for this age criterion. Besides, older participants were also required to meet the retired criterion. Non-retired older people may have better cognitive and physical capabilities than older people in general, which means they are less representative of the population of older people. Thus, older participants in the study were required to be over 60 years old and have retired.

Each participant viewed a photo of an older or younger Chinese man or woman and rated them on a number of characteristics (see Figure 3.1). A six variable design was used, although the statistical analysis was broken down into different components. There were four between-

[12]URL: https://emergency.unhcr.org/protection/persons-risk/older-persons#:~:text=An%20older%20person%20is%20defined,or%20age%2Drelated%20health%20conditions

participant independent variables: the gender of the person in the photo (male versus female, henceforth target person); the age of the person in the photo (young vs older); the gender of the participant (male vs female); and the age of the participant (young vs older). There were two within-participant independent variables: the three digital technologies asked about (desktop computer vs laptop computer vs smartphone); and the characteristic asked about (use vs expertise). The dependent variable was the rating given about the person in the photo for their likelihood of use of the digital technology and their expertise with the technology. As explained, the design of the study included six variables, but to make it easier to interpret the results, I broke the statistical analysis down into several components. To investigate the results of the perceptions of young participants, two 4-way ANOVA analyses were conducted, one on the likelihood of use of the three devices and one on the expertise of the target person (Target Age x Target Gender x Device x Participant Gender). The same two ANOVAs were then conducted for the older participants. Then, to investigate the effect of participant age, two 5-way ANOVA analyses were conducted, one on the likelihood of use of the three devices and one on the expertise of the target person (Target Age x Target Gender x Device x Participant Gender x Participant Age).

In addition, to check whether participants perceived the person in the photo as intended, they were asked how old they thought the person in the photo was and whether the person was old. Finally, to complement this information they were asked what minimum age they considered old age to start.

3.2.2 Participants

85 young Chinese people participated, 42 university students (studying computer science and other technology-related subjects), and 43 professional technology developers (working in software development, UI and UX design, product management, and other related jobs). 43 (50.6%) were men, 41 (48.2%) were women, and 1 (1.2%) preferred not to give a gender. Their ages ranged from 20 to 33 years, with a median age of 26 years.

101 older Chinese people participated; 38 (37.6%) were men, 63 (62.4%) were women. Their ages ranged from 60 to 85 years, with a median age of 63 years.

Table 3.1 shows the age and gender breakdown for each group of participants.

To keep the study very short, no other demographic information was collected about participants.

Table 3.1: Age distribution of participants in Study 1

	Younger people		Older people
	Students	**Developers**	
	N = 42	N = 43	N = 101
Age			
20-29	42	33	-
30-35	-	10	-
60-69	-	-	90
70-79	-	-	8
≥ 80	-	-	3
Gender			
Male	24	19	38
Female	18	23	63
Other	-	1	-

3.2.3 Materials

A short questionnaire included a photograph of either an old or young Chinese man or woman (see Figure 3.1). Eight different versions of the questionnaire were created, each with a different photograph. Four of the photographs were of older people, four were of younger people. Photographs were chosen carefully so that the person looked to be in their 70s for the older people, and in their late 20s/early 30s for the younger people (so a little older than most of the young participants for the study, but people they would still consider young). All the photographs were chosen to be close-up shots of a person reading a book, so that all the people were in the same context. This was to avoid confounding factors from the context of the photo that might have affected participants' perceptions. For example, if I had photographs with some people reading a book, and other people are playing a video game, then participants might think people playing the video game were more expert with computers.

All the photographs were copyright-free images from the Internet.

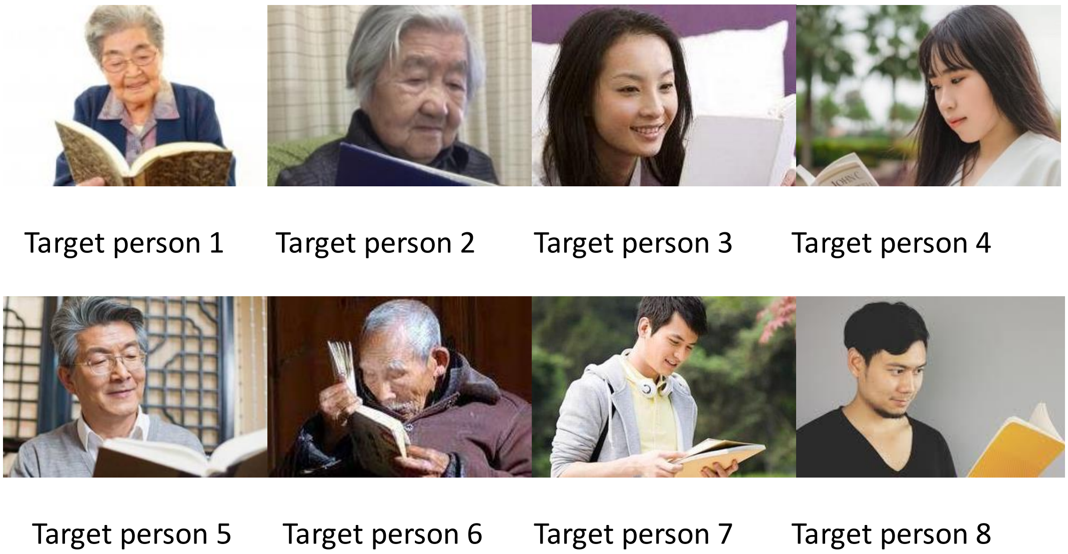


Figure 3.1: Photographs of young and older women and men used in the study

The short questionnaire which followed the photo included nine questions. First, three questions asked about the age of the person in the photo and old age in general:

- How old do you think the person is?
- Would you call this person old?
- What is the minimum age you would think of someone as old?

Then three questions asked about the person's use of digital technologies:

- How likely do you think it is that this person uses a desktop computer regularly (rated on a scale from 1 = not at all likely to 7 = very likely)?
- How likely do you think it is that this person uses a laptop computer regularly? (same rating as above)
- How likely do you think it is that this person uses a smartphone regularly? (same rating as above)

Then three questions about the person's expertise with the same digital technologies:

- How expert do you think this person would be with a desktop computer? (rated on a scale from 1 = not at all expert to 7 = very expert)

- How expert do you think this person would be with a laptop computer? (same rating as above)
- How expert do you think this person would be with a smartphone? (same rating as above)

Finally, respondents were asked their own age and gender.

The questionnaire was given in Chinese; it was adapted from Petrie (2018), then translated into Chinese. An example of the questionnaire can be found in Appendix B.

3.2.4 Pilot study

A pilot study was conducted to ensure the questions were clear and suitable for a Chinese sample in terms of difficulty, comprehension, and length. Four participants were recruited to complete the questionnaire. Two young participants were Chinese students (ages: 24, 25) at the University of York. Although they were not studying computer science or other technology-related subjects, it was assumed that they could still identify any problems in the questionnaire and give suggestions. The pilot study was also conducted with two older Chinese people from the researcher's household (Age: both 58). Even though they did not meet the inclusion criteria for older adults, one of them had been retired for over five years. Thus, they could identify any problems in the questionnaire for an older sample.

The pilot study participants gave useful feedback: for example, they wanted me to emphasize the different parts of each question because the questions were relatively similar. Therefore, I bolded the font to emphasize the highlighted portion of each question. In addition, I added more instructions to explain to participants that they should give ratings according to their impression of the person in the picture rather than a rating about young or older people in general.

3.2.5 Procedure

The study received ethical approval from the Physical Sciences Ethics Committee of the University of York.

Opportunistic and snowball sampling were used during participant recruitment for both young and older participants. Young participants were recruited via a number of different methods, including WeChat (a Chinese instant messaging calling, social media, and mobile payment app) and email. For the recruitment of young technologists, my supervisor provided a list of Chinese graduates from the MSc HCIT course at the University of York with whom she was still in touch. I emailed them to ask whether they would participate in the study and to also ask their colleagues (i.e. snowball sampling). A similar method was used in recruiting student participants. Students were recruited through my personal contacts. I first contacted my Chinese friends who are computer science students at the University of York in the United Kingdom and asked them whether they would participate in the study, then asked their Chinese friends who were studying computer science or related subjects whether they would participate in the study. All the young participants were sent a link to the questionnaire in Qualtrics and completed it online.

Older participants were recruited through my personal contacts and by publicity at an activity center for older Chinese people in Hefei in the Province of Anhui in China. I first contacted my family members who met the criteria of older participants (over 60 years old and retired), then asked them whether they would participate in the study and to also ask their friends (i.e. snowball sampling). These older participants were contacted and recruited through WeChat, then they were sent a link to the questionnaire in Qualtrics and completed online. I recruited most of the older participants at an activity center for older people in person (i.e. opportunistic sampling); these older participants completed the questionnaire on paper.

Young and older participants followed the same procedure: Firstly, I briefly introduced the study. Then they were asked to complete an informed consent form showing they understood and consented to be part of the study. Next, they were asked to complete the questionnaire. The study was anonymous, and each participant was assigned a code number. Participants could ask questions at any time or withdraw from the study. If they wished to withdraw, I would delete their data according to the code they provided.

3.2.6 Data analysisBecause there was a large amount of rating data, distributions were close to normal. Thus, parametric statistics were appropriate. Mixed analysis of variance (ANOVA) was used to analyse the result of rating questions. I chose to use ANOVA for the analysis of the data, as I had six variables to investigate and I wanted to investigate not only the main effects of each variable but also some of the interactions between the variables. In particular, I was interested in the possible "double standard" about older women (see RQ6). Although ANOVA as a parametric analysis makes assumptions about the data (e.g. normality, heterogeneity), with reasonably large samples, the results of ANOVA are robust (Keppel & Wickens, 2004). It is also the only statistical analysis which would allow me to investigate a range of main effects and interactions without inflating the Type I error rate which would occur by conducting many individual non-parametric tests.

It would have been possible to conduct a MANOVA, combining the likelihood of use and expertise dependent variables into one analysis. This would have controlled the Type I error rate even more tightly and allowed an immediate comparison between the two dependent variables. However, MANOVA makes even more assumptions about the data than ANOVA and the interpretation of the results would have been even more complex, so I decided to use the breakdown of the analysis into a number of ANOVAs (see section 3.2.1).

Two-tailed tests were used throughout the study, with a probability level of 0.05. Bonferroni post-hoc comparisons were used, with adjusted probability levels where main effects or interactions needed to be broken down into constitutions parts.

3.3 Results

3.3.1 Ageism and sexism among young Chinese technologists3.3.1.1 Perception of the minimum age of "old age" by young Chinese technologists

RQ1a investigated the minimum age that young Chinese technologists perceive old age to start. Then, RQ1d explored the difference between young men and women Chinese technologists. Just over half the young Chinese participants (45/85, 52.9%) stated that the minimum age at which old age begins at 60 years. The overall mean minimum age given was 61.3 years (SD: 5.2), ranging from 50 to 70 years.

An analysis was conducted to investigate whether young men and women differed in their perception of old age (RQ1d). One participant was excluded because as they gave their gender as "other", giving a sample of 84 young participants. There was no significant difference between young men and women in the perception of the minimum age of "old age": $F(1, 82) = 0.29$, $p = 0.60$, $\eta p^2 = 0.00$.

3.3.1.2 Checking the manipulation of the photos: Perception of the age of the target person by young Chinese technologists

To check that the target people were perceived as had been intended, participants were asked what they thought the age of the target person was. The mean estimated age for older target persons was 73.5 years (SD = 9.36), and young target persons was 26.9 years (SD = 3.73). This matched with the intention of the photographs, I researcher and my supervisor estimated the older target persons to be between 70 and 80 years and young target persons to be between 20 and 30 years. A two-way ANOVA was conducted that examined the effect of Target Person Age and Gender on the perception of the age of the target person. It showed a main effect for Target Person Age ($F (1, 81) = 1048.82$, $p < .001$, $\eta p^2 = 0.93$), the effect size is large, which means older target persons were estimated to be significantly older than young target persons. The mean perceived age of older target persons was 73.81 (SD = 9.36), for young target persons 26.91 (SD = 3.73). The standard deviation for the older target person is much bigger than young target persons: the perception of the minimum age of older target persons is 60 years while the maximum age is 90 years old for older target persons, a range of 30 years; for young target persons, the minimum age of the young target persons is 20 years while the maximum age is 35 years, a range of only 15 years. This suggests that Chinese young participants have more difficulty assessing the age of older people than of young people.

There was no main effect for Target Person Gender ($F (1, 81) = 1.64$, $p= .20$, $\eta p^2 = .02$). However, there was a significant interaction between Target Person Age and Gender ($F (1, 81) = 10.48$, $p = 0.002$, $\eta p^2 = 0.11$), however the effect size is small. This interaction is illustrated in Figure 3.2. For both young and older target persons, there was a significant difference between the perceived age of the men and the women; in the case of the young target person, the men were perceived as older than the women ($F (1, 41) = 7.16$, $p = 0.01$, $\eta p^2 = 0.15$, Mean perceived age for men = 28.29, SD = 2.75; Mean perceived age for women = 25.45, SD = 4.11), whereas in the case of the older target person, the women were perceived as older than the men ($F (1, 40) = 5.76$, $p = 0.02$, $\eta p^2 = 0.13$, Mean perceived age for men = 70.68, SD = 10.72; Mean perceived age for women = 77.25, SD = 6.17). The effect size is small for both young and older target person.

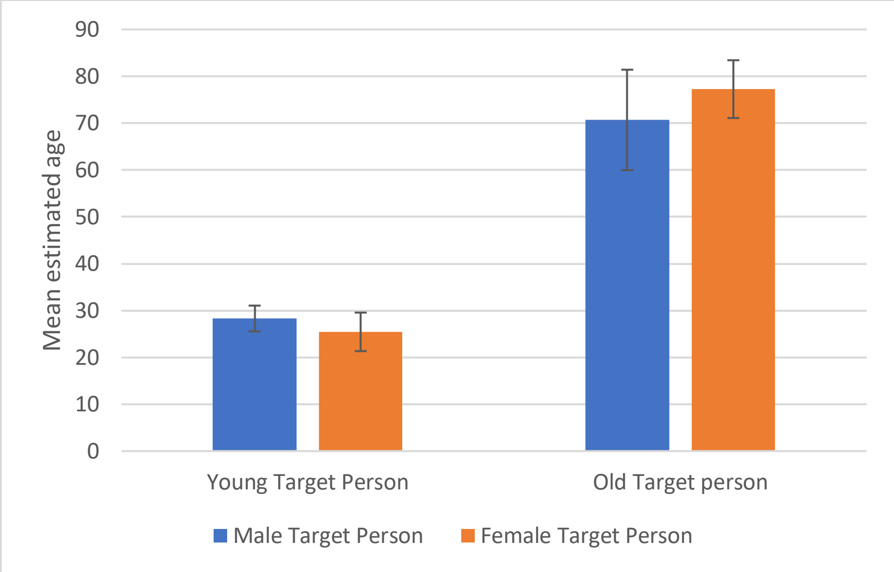


Figure 3.2: Mean age of young/old and male/female target people as estimated by young Chinese technologists

The great majority of young Chinese technologists classified the target person into the anticipated group when the researcher compared the participants' estimated age of the target person with the anticipated age of the person. Only two young Chinese technologists classified the target person into a different age group from that expected. Both participants estimated that one of the older men (target person 5) was 60 years old. One of these participants stated that old age began at 65 years, and the other stated that old age began at 70 years. Therefore, they would not call the target person old. These two young Chinese participants were therefore excluded from further analyses.

3.3.1.3 Perception of likelihood of use of digital technologies and expertise of target person of different ages and genders by young Chinese participants

To investigate the effects of the Age and Gender of the target person on ratings of their use and expertise with the three technologies, four-way mixed measures ANOVAs were conducted on the ratings: one on the ratings of use (testing RQ2a, RQ2d, RQ4a, RQ4d) and one on the ratings of expertise (testing RQ3a, RQ3d, RQ5a, RQ5d). It also investigated whether they have 'double standard' about older women (testing RQ6a, RQ6c, RQ6g, RQ6h).

The independent variables in the ANOVAs were: Device (within participant measure, 3 levels: desktop, laptop, smartphone), Age of the target person (between participant measure, 2 levels: Young, Old) and Gender of the target person (between participant measure, 2 levels: woman, man), Gender of young Chinese participants (between participant measure, 2 levels: woman, man). The study analyzed data from 82 young Chinese participants (one participant who did not give their gender and two participants who classified the target person into the wrong age group were excluded).

A summary of the results of the ratings of likelihood of use of digital technologies and expertise of target person of different ages and genders by young Chinese participants in given in the Table 3.2. The detailed results are presented below.

Table 3.2. Summary of the results of the ratings of likelihood of use of digital technologies and expertise of target person of different ages and genders by young Chinese participants

RQ	p-value	Effect size	Outcome
RQs on likelihood of use by young Chinese participants			
RO2a	< 0.001	large	Difference found
RQ2d	1.00	small	No difference
RQ4a	0.07	small	No difference
RQ4d	0.59	small	No difference
RQs one expertise by young Chinese participants			
RO3a	< 0.001	large	Difference found
RQ3d	0.71	small	No difference
RQ5a	0.11	small	No difference
RQ5d	0.50	small	No difference
RQ on “double standard” by young Chinese participants			
RO6a	0.05	small	Difference found
RQ6c	0.52	small	No difference
RQ6g	0.91	small	No difference
RQ6h	0.69	small	No difference

For the ANOVA on the ratings of likelihood of use of devices, there was a main effect for Device: $F\ (2, 148) = 45.06$, $p < 0.001$, $\eta p^2 = 0.38$). Figure 3.3 shows that young Chinese participants thought all target persons, regardless of age or gender, were more likely to use a smartphone than a laptop and in turn more likely to use a laptop than a desktop computer. Bonferroni post hoc comparisons showed that all these comparisons were significant (all $p < 0.001$) and the ηp^2 value shows that this is a large effect.

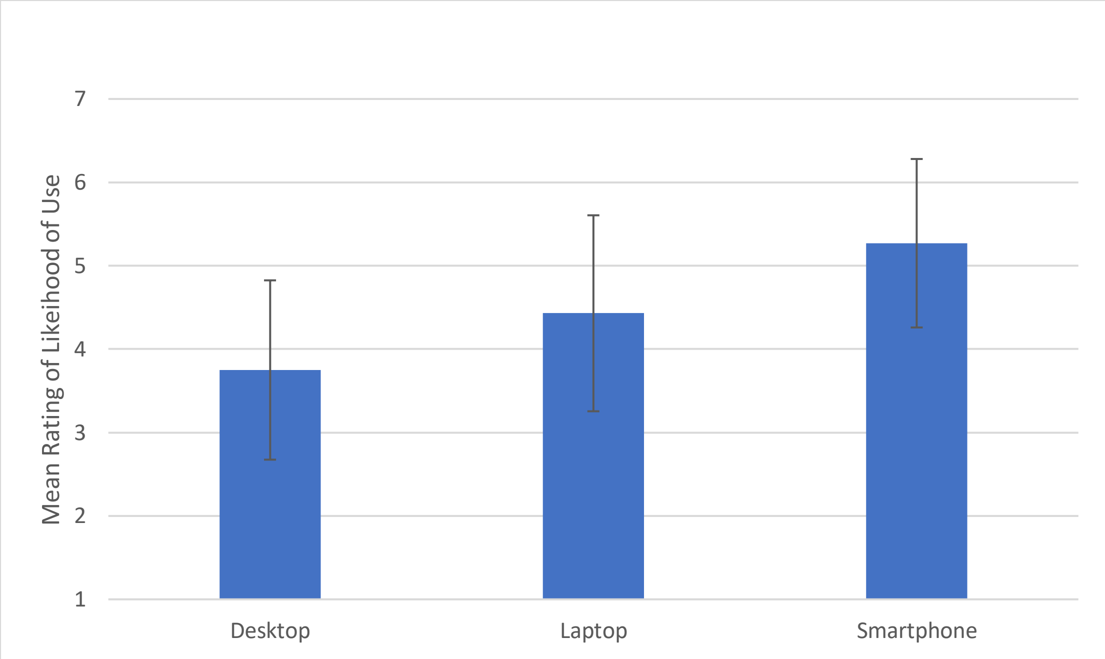


Figure 3.3: Mean ratings of likelihood of use for all target people by young Chinese participants

There was also a main effect for Target Person Age: $F (1, 74) = 94.75$, $p < 0.001$, $\eta p^2 = 0.56$. This showed that young Chinese participants rated the likelihood of use of all devices by young target persons significantly higher (mean: 5.91, SD: 0.94) than older target persons (mean: 2.95, SD 1.65). The effect size is also large.

There was a significant interaction between Device and Target Person Age: $F (2, 148) = 16.31$, $p < 0.001$, $\eta p^2 = 0.18$. Figure 3.4 shows that for young target persons, there is a significant increase in the perception of the likelihood of use from desktops to laptops to smartphones (all Bonferroni post hoc comparisons significant at $p < 0.01$). However, for older target persons, there was no difference between the perception of the likelihood of using laptops and desktop computers; but a significantly higher perception of their likelihood of use of smartphones in comparison to either desktops or laptops (both Bonferroni post hoc comparisons $p < 0.001$).

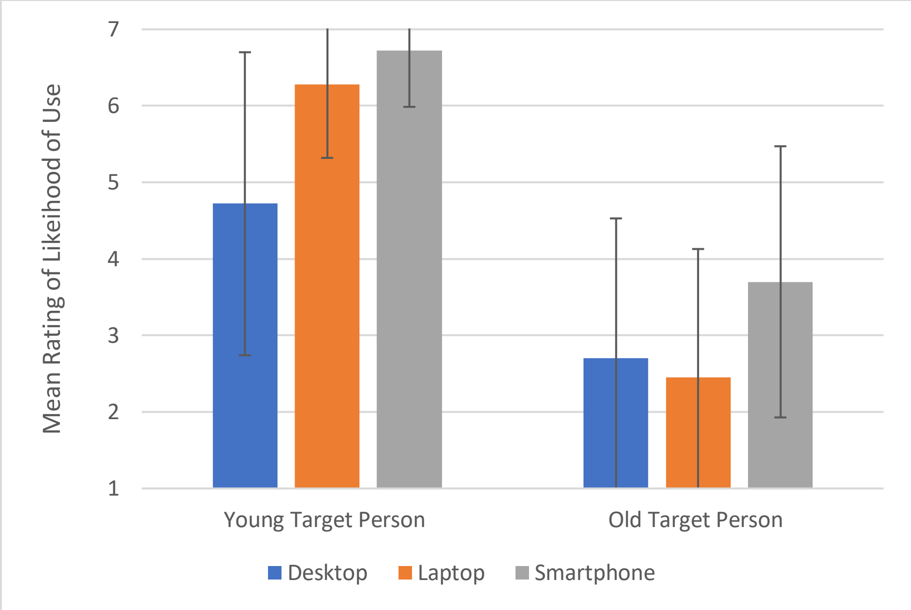


Figure 3.4: Mean ratings of likelihood of use for young and older target persons for three digital devices by young technologists

There was also a significant interaction between the Target Person Gender and Target Person Age: F (1, 74) = 3.89, p = 0.05, $\eta p^2 = 0.05$. Figure 3.5 and the post hoc analysis show there was a significant difference in the perceptions of the likelihood of use between young and old male target persons, with young male target persons seen as more likely to use all three devices than older male target persons. The difference was also significant for the female target person, but even larger, 1.5 times the difference for males. In addition, there was a significant difference between male and female older target persons; that is, female older target persons were seen as significantly less likely to use technologies than male older target persons ($p < 0.05$). But there was no significant difference between male and female young target persons.

There was no main effect for the Target Person Gender and the Participants Gender in young Chinese participants' perception of the likelihood of use technologies of the target person.

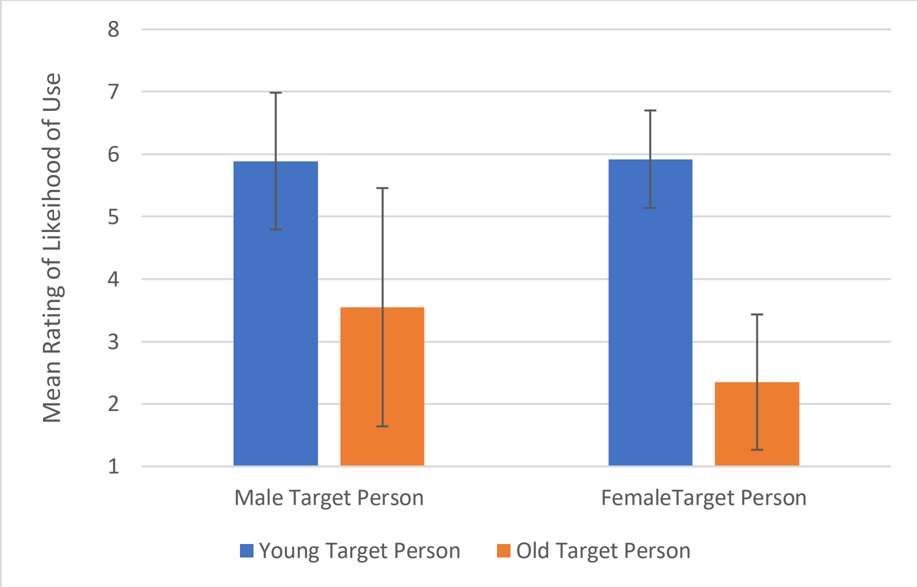


Figure 3.5: Mean ratings of likelihood of use for young/older and male/female target persons by young Chinese technologies

For the ANOVA on the ratings of the level of expertise in these technologies, there was a main effect for Device: $F(2, 148) = 37.78$, $p < 0.001$ $\eta p^2 = 0.34$. Figure 3.6 shows that young Chinese participants thought all target persons, regardless of age or gender, had higher expertise with smartphones than with laptops or desktop computers. Bonferroni post hoc comparisons showed that smartphone ratings were significantly higher than desktop and laptop computers ($p < 0.001$), and the ηp^2 value shows that this is a large effect.

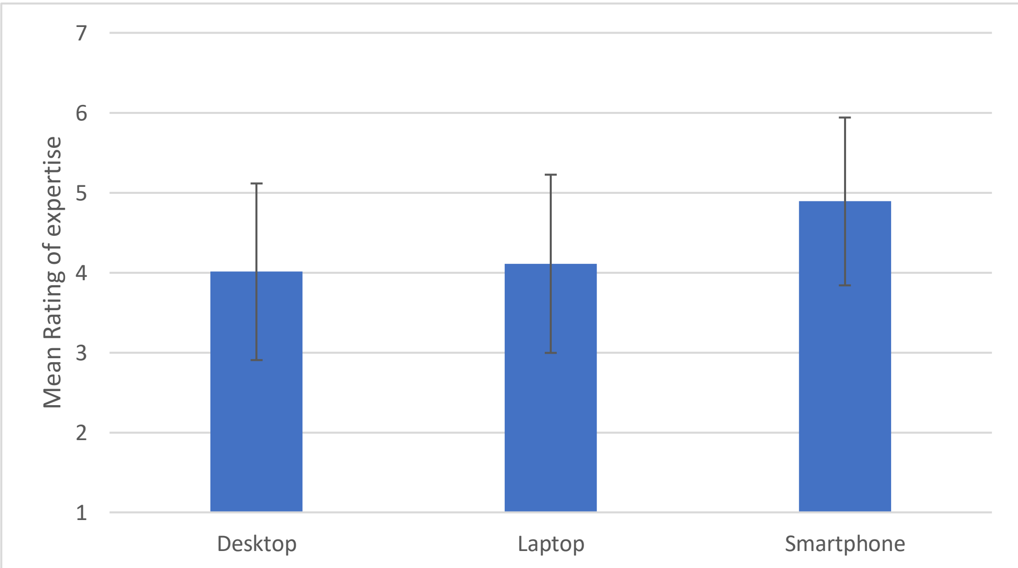


Figure 3.6: Mean ratings of expertise for all target persons by young Chinese technologists

There was also a significant main effect for Target Person Age: $F(1, 74) = 123.52$, $p < 0.001$ ηp^2

= 0.63. Participants rated the level of expertise with these devices by young target persons significantly higher (mean: 5.92, SD: 1.05) than older target persons (mean: 2.63, SD: 1.50). The effect size is large.

There was also a significant main effect for Participant Gender: F (1, 74) = 4.528, p = .037 ηp2 = 0.058). Young male participants (mean: 4.54, SD: 2.01) gave a significantly higher rating of the level of expertise with all target persons than the rating was given by young female participants (mean: 4.07 SD: 2.15). However, the effect size is small.

Finally, there was a significant interaction between Device and Target Person Gender: F (2, 148) = 7.77, $p < 0.001$ $\eta p^2 = 0.10$. Figure 3.7 shows that for male target persons, there is a difference in the perception of the expertise between laptops and smartphones ($p < 0.005$ on Bonferroni post-hoc comparison), but no significant difference between laptops and desktop computers. However, for female target persons, there were significant differences in expertise ratings between all three digital technologies (desktop vs. laptop: $p < 0.05$; laptop vs. smartphone and desktop vs. smartphone $p < 0.001$).

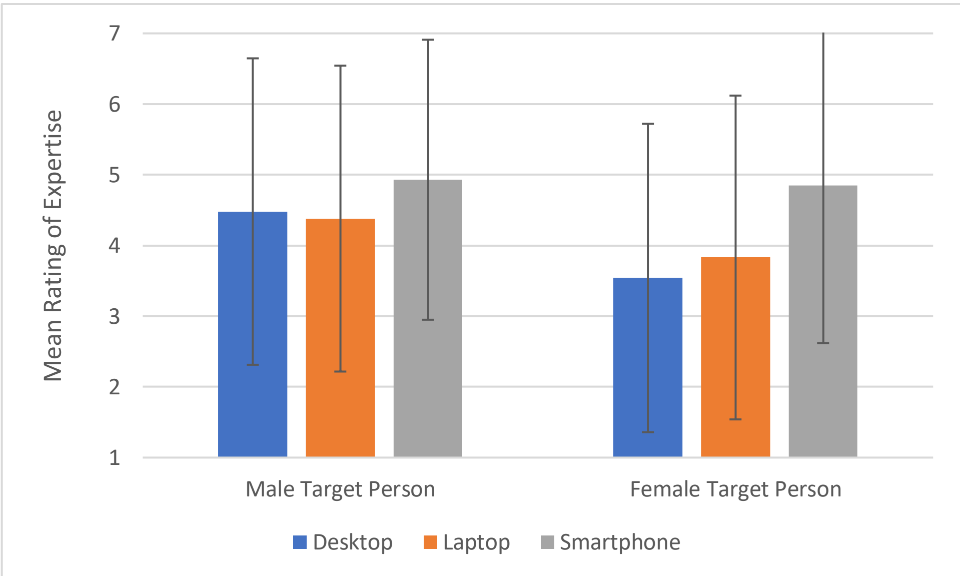


Figure 3.7: Mean ratings of expertise for men and women target persons for three devices by young Chinese participants

There were no other significant interactions between the Target Person Age and Target Person Gender in young Chinese participants' perception of the expertise of the target person. And there was no main effect on the Target Person Gender.

In summary, these results support the following research questions:

RQ2a) Is there a difference in young Chinese technologists' attitudes to older and younger people as users of digital technologies?

RQ3a) Is there a difference in young Chinese technologists' attitudes to older and younger people as experts in digital technologies?

RQ6a) Is there a difference in young Chinese technologists in their attitudes to older women as users of digital technologies in comparison to older and younger men and younger women?

But in contrast, these results is not support the following research questions:

RQ2d) Is there a difference between young men and women Chinese technologists in their attitudes to older and younger people as users of digital technologies?

RQ3d) Is there a difference between young men and women Chinese technologists in their attitudes to older and younger people as experts in digital technologies?

RQ4a) Is there a difference in young Chinese technologists' attitudes to men and women as users of digital technologies?

RQ4d) Is there a difference between young men and women Chinese technologists in their attitudes to men and women as users of digital technologies?

RQ5a) Is there a difference in young Chinese technologists' attitudes to men and women as experts in digital technologies?

RQ5d) Is there a difference between young men and women Chinese technologists in their attitudes to men and women as experts in digital technologies?

RQ6c) Is there a difference in young Chinese technologists in their attitudes to older women in their expertise with digital technologies in comparison to older and younger men and younger women?

RQ6g) Is there a difference between young men and women Chinese technologists in their attitudes to older women as users of digital technologies?

RQ6h) Is there a difference between young men and women Chinese technologists in their attitudes to older women as experts in digital technologies?

3.3.2 Ageism and sexism among older Chinese people

3.3.2.1 Perception of the minimum age of "old age" by older participants

RQ1b investigated the minimum age that older Chinese people perceive old age to start. Then RQ1e explored the difference between older Chinese men and women about this question. 5 of the 101 older Chinese participants who took part in the study did not answer the question about the minimum age at which old age starts, so I analyzed data from the remaining 96 older participants. Most older Chinese participants (86 out of 96, 89.6%) thought that old age begins between 60 and 70 years. 29 older participants stated that the minimum age at which old age begins is 60 years, 28 older participants thought it is 65 years, 29 older participants reported it is 70 years. The overall mean minimum age was 65.42 years (SD: 5.43), ranging from 50 to 80 years.

An analysis was conducted to investigate whether older Chinese men and women differed in their perception of old age. There was no significant difference between male and female older Chinese participants in the minimum old age $F (1, 94) = 0.12$, $p = 0.73$ $\eta p^2 = 0.01$.

3.3.2.2 Checking the manipulation of the photos: Perception of the age of the target person by older participants

To check that the target people were perceived as had been intended, participants were asked what they thought the age of the target person was. The mean estimated age for the older target people was 76.6 years (Standard Deviation = 8.33), and young target people was 32.7 years (Standard Deviation = 7.84). This matched with the choice of photographs, of the young target people being aged between 20 to 30 years, and the older target people between 70 and 80 years.

A two-way ANOVA was conducted that examined the effect of Target Person Age and Gender on the perception of the age of the target person. It showed a main effect for Target Person Age: $F (1, 97) = 758.75$, $p < 0.001$, $\eta p2 =0.89$. But there was no main effect for Gender: $F (1, 97) = 0.09$, $p= 0.77$, $\eta p^2 = 0.001$. However, there was a significant interaction between Target Person Age and Gender: $F (1, 97) = 7.44$, $p = 0.01$, $\eta p2 =0.07$. This interaction is illustrated in Figure 3.8. In the case of older target persons, the women were perceived as significant older than the men ($F (1, 58) = 5.46$, $p = 0.02$, $\eta p^2 = 0.09$, mean perceived age for men = 74.26, SD

= 9.86; mean perceived age for women = 79.1, SD = 5.42). However, in the case of young target persons, there was no significant difference ($F (1, 39) = 2.621$, $p = 0.114$, $\eta p^2 = 0.063$, mean perceived age for men = 34.5, SD = 8.26, mean perceived age from women = 30.61, SD = 6.95). The effect size is small for both young and older target persons.

Figure 3.8: Mean estimated age of the young/older and male/female target for young persons as estimated by older Chinese participants

The majority of older Chinese participants classified the target person into the anticipated group when comparing the participants' estimated age of the target person. Six older Chinese participants classified the target person into different groups than were expected. Five of them estimated the age range of one of the older men (target person 5) between 60 and 75 years old, but the minimum age for old age they gave was between 70 and 80 years. Therefore, they would not call the target person old. One of them estimated that one of the young men (target person 8) was 30 years old, but the participant thought the target person was older person. In addition, two older Chinese participants did not finish this set of questions. These eight participants were therefore excluded from further analysis.

3.3.2.3 Perception of use and expertise of target people of different ages and genders

To investigate the effects of the Age and Gender of the target person on ratings of their use and expertise with the three technologies, four-way mixed measures ANOVAs were conducted on the ratings: one on the ratings of use (RQ2b, RQ2e, RQ4b, RQ4e) and one on the ratings of expertise (RQ3b, RQ3e, RQ5b, RQ5e). It also investigated whether they have ‘double standard’ about older women (RQ6b, RQ6d, RQ6i, RQ6j).

A summary of the results of the ratings of likelihood of use of digital technologies and expertise of target person of different ages and genders by older Chinese participants is given in the Table 3.3.

Table 3.3. Summary of the results of the ratings of likelihood of use of digital technologies and expertise of target person of different ages and genders by older Chinese participants

RQ	p-value	Effect size	Outcome
RQs on likelihood of use by older Chinese participants			
RO2b	< 0.001	large	Difference found
RQ2e	0.16	small	No difference
RQ4b	0.13	small	No difference
RQ4e	0.68	small	No difference
RQs one expertise by older Chinese participants			
RO3b	< 0.001	large	Difference found
RQ3e	0.16	small	No difference
RQ5b	0.36	small	No difference
RQ5e	0.84	small	No difference
RQ on “double standard” by older Chinese participants			
RO6b	0.42	small	No difference
RQ6d	0.42	small	No difference
RQ6i	0.91	small	No difference
RQ6j	0.21	small	No difference

The independent variables in the ANOVAs were: Device (within participant measure, 3 levels: desktop, laptop, smartphone), Target Person Age (between participant measure, 2 levels: Young, Old), Target Person Gender (between participant measure, 2 levels: woman, man) and Gender of older Chinese participants (between participant measure, 2 levels: woman, man).

For the ANOVA on the ratings of likelihood of use of devices, there was a main effect for Device: $F(2, 170) = 13.06$, $p < 0.001$, $\eta p^2 = 0.13$. Figure 3.9 shows that older Chinese participants thought all target persons, regardless of age or gender, were more likely to use a smartphone than desktop computers or laptop computers. Bonferroni post hoc comparisons show that smartphone was significantly different from desktop and laptop computers separately ($p < 0.001$). But there was no significant difference between desktop and laptop computers.

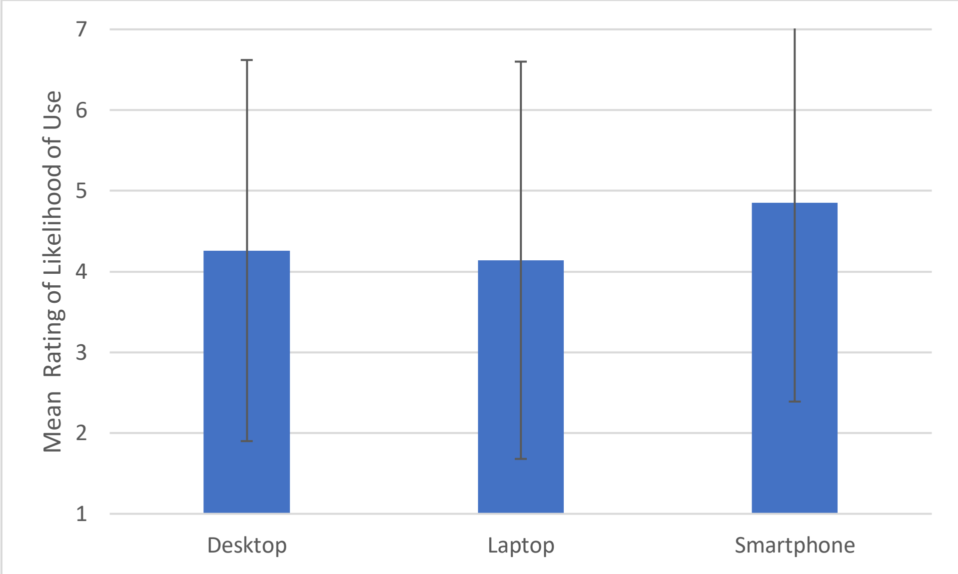


Figure 3.9: Mean ratings of likelihood of use of digital technologies for all target persons by older Chinese participants

There was also a main effect for Target Person Age: $F (1, 85) = 63.04$, $p < 0.001$, $\eta p^2 = 0.43$. This showed that older Chinese participants rated the likelihood of using all devices by young target persons significantly higher (mean: 6.16, SD: 1.10) than older target persons (mean: 3.16, SD: 2.01). The effect size is also large. But there were no main effects for Target Gender or Participant Gender, and no significant interaction between Target Gender and Target Age.

Finally, there was a significant interaction between Device and Target Person Gender: $F (2, 170) = 3.85$, $p = 0.02$, $\eta p^2 = 0.04$. Figure 3.10 shows that for male target persons, there is a significant increase in the perception of the likelihood of use from desktops to laptops to smartphones, a significantly higher perception of their likelihood of use of smartphones in comparison to desktop ($P < 0.001$) and laptop computers ($p < 0.05$). For female target persons, there is no difference between the perception of the likelihood of using desktop and smartphones; significantly lower perception of their likelihood of use of laptop computers in comparison to either desktop computers ($p < 0.05$) or smartphones ($p < 0.001$).

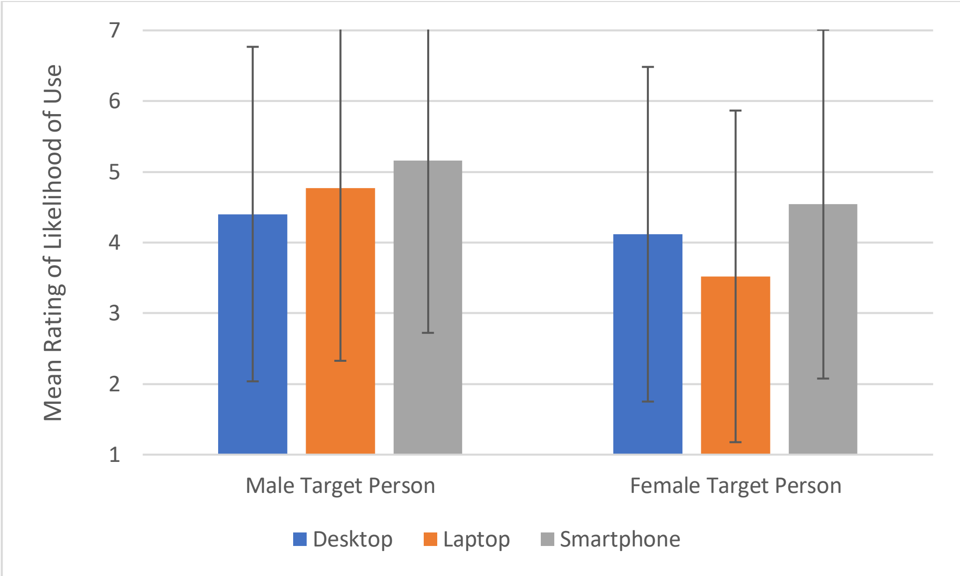


Figure 3.10: Mean ratings of likelihood of use for the young and older target persons for three devices by older Chinese participants

There was no main effect for the Target Person Gender and the Participant Gender in older Chinese participants' perception of the likelihood of use technologies of the target person. And there was no significant interaction between Target Person Age and Target Person Gender.

For the ANOVA on the ratings of expertise in these technologies, there was a main effect for Device: $F(2, 170) = 7.59$, $p < 0.001$, $\eta p^2 = 0.08$. Figure 3.11 shows that older Chinese participants thought all target persons, regardless of age or gender, had higher expertise in using smartphones than laptops or desktop computers. Bonferroni post hoc comparisons showed that smartphone ratings were significantly higher than desktop ($p < 0.05$) and laptop computer ($p < 0.001$). But there was no significant difference between desktop and laptop computers.

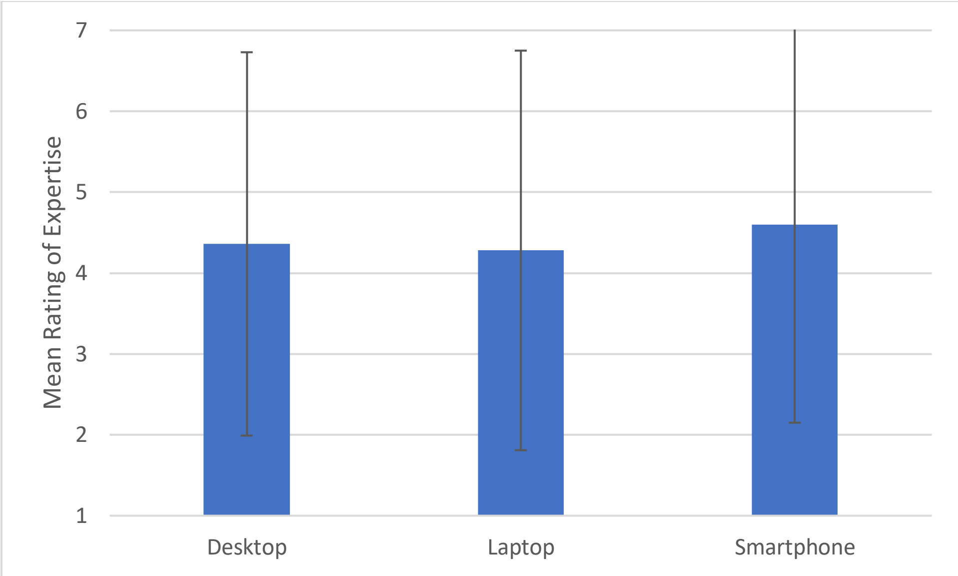


Figure 3.11: Mean ratings of expertise for all target persons by older Chinese participants

There was also a significant main effect for Target Person Age F (1, 85) = 81.07, $p < 0.001$, $\eta p^2 = 0.49$. Older Chinese participants rated the level of expertise with these devices by young target persons significantly higher (mean: 6.38, SD: 1.00) than older target persons (mean: 2.99, SD: 2.03). The effect size is also large. However, there was no significant effect for Target Gender and Participant Gender, and no significant interaction between Target Gender and Target Age.

There were two significant interactions. There was a significant interaction between Device and Target Gender with small effect: F (2, 170) = 3.76, $p = 0.03$, $\eta p^2 = 0.04$. Figure 3.12 shows that for male target persons, smartphones were significantly higher than desktop ($p < 0.05$) and laptop computers ($p < 0.05$) in the perception of the expertise. But there was no significant difference between desktop and laptop computers. However, for female target persons, desktop computers ($p < 0.05$) and smartphones ($p < 0.05$) were significantly higher than laptop computers, but there was no significant difference between desktop computers and smartphones.

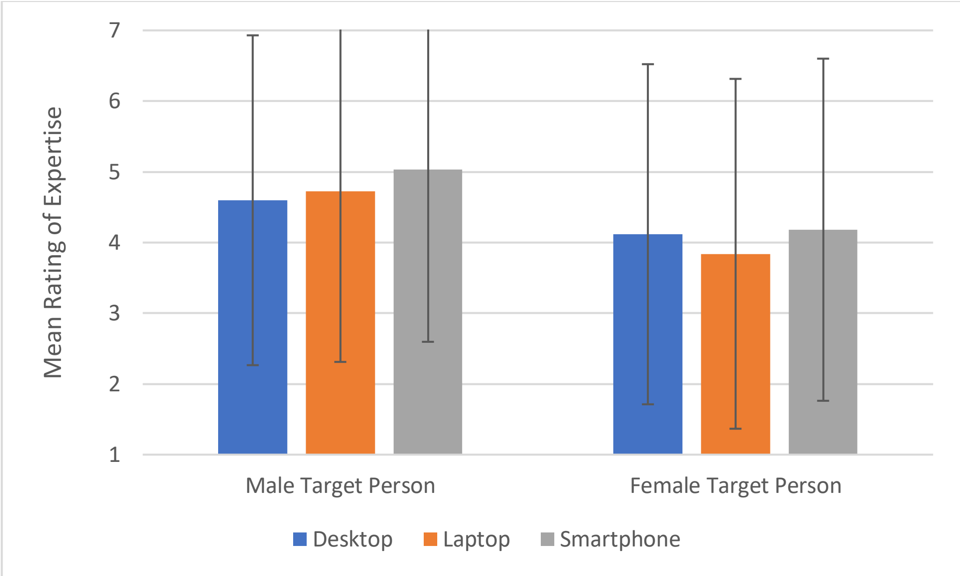


Figure 3.12: Mean ratings of expertise for male and female target persons for three devices by older Chinese participants

There was also a significant interaction between Device and Target Age $F(2, 170) = 5.01$, $p = 0.01$, $\eta p^2 = 0.06$. Figure 3.13 shows that for older target persons, expertise with laptop computers is significantly lower than with desktop computers ($p < 0.05$) and smartphones ($p < 0.05$), but there is no significant difference between desktop computers and smartphones. However, for young target persons, there is a significant increase in the perception of the expertise of use from desktops to laptops to smartphones, smartphones are significantly higher than desktop ($p < 0.05$) and laptop computers ($p < 0.05$), but no significant difference between desktop and laptop computers.

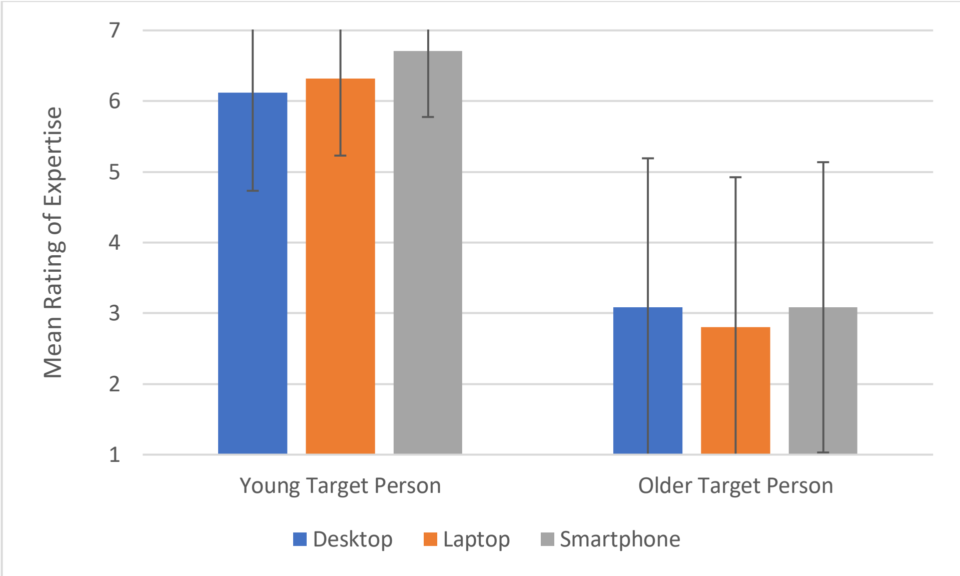


Figure 3.13: Mean ratings of expertise for young and older Target persons for three devices by older Chinese people

There was no main effect for Target Person Gender and Participant Gender in terms of expertise in using digital technologies. There was no significant interaction between Target Person Age and Target Person Gender.

In summary, these results support the following research questions:

RQ 2b) Is there a difference in older Chinese people's attitudes to older and younger people as users of digital technologies?

RQ3b) Is there a difference in older Chinese people's attitudes to older and younger people as experts in digital technologies?

In contrast, the following research questions were not supported:

RQ2e) Is there a difference between older Chinese men and women in their attitudes to older and younger people as users of digital technologies?

RQ3e) Is there a difference between older Chinese men and women in their attitudes to older and younger people as experts in digital technologies?

RQ4b) Is there a difference in older Chinese people's attitudes to men and women as users of digital technologies?

RQ4e) Is there a difference between older Chinese men and women in their attitudes to men and women as users of digital technologies?

RQ5b) Is there a difference in older Chinese people's attitudes to men and women as experts in digital technologies?

RQ5e) Is there a difference between older Chinese men and women in their attitudes to men and women as experts in digital technologies?

RQ6b) Is there a difference in older Chinese people in their attitudes to older women as users of digital technologies in comparison to older and younger men and younger women?

RQ6d) Is there a difference in older Chinese people in their attitudes to older women as in their expertise digital technologies in comparison to older and younger men and younger women?

RQ6i) Is there a difference between older Chinese men and women in their attitudes to older women as users of digital technologies?

RQ6j) Is there a difference between older Chinese men and women in their attitudes to older women as experts in digital technologies?

3.3.3 Differences between young and older Chinese participants

3.3.3.1 Perception of the minimum age of "old age"

RQ1c investigated a difference between young Chinese technologists and older Chinese people in their perception of the minimum age when old age starts. One young participant stated their gender was "other," and five older participants did not answer the question. Thus, the study analyzed data from the remaining 180 participants. A two-way ANOVA was conducted that examined the effect of Participants Age and Participants Gender on the perception of the minimum of old age. There was a main effect for Participant Age: $F(1, 176) = 25.70$, $p < .001$ $\eta p^2 = 0.13$), with young Chinese participants giving a mean estimate that old age begins at 61.33 years (SD: 5.20) while older Chinese participants gave a mean estimate that old age begins at 65.42 years (SD: 5.43), although the magnitude of the difference is not great. There was no significant interaction between Participant Age and Participant Gender.

3.3.3.2 The difference in perception of use and expertise of target person of different ages and genders by young and older Chinese participants

To investigate the difference between young Chinese technologists and older Chinese people in their perception of the target person as users of and expertise using three digital technologies, five-way mixed measures ANOVAs were conducted on the ratings: one on the ratings of use (RQ2c, RQ4c) and one on the ratings of expertise (RQ3c, RQ5c). It also investigated whether they have 'double standard' about older women (RQ6e, RQ6f).

A summary of the comparison of the ratings of likelihood of the use of digital technologies and expertise of target persons of different ages and genders between young and older Chinese participants is shown in Table 3.4. The detailed results are presented below.

Table 3.4. Comparison of the ratings of likelihood of the use of digital technologies and expertise of target persons of different ages and genders between young and older Chinese participants

RQ	p-value	Effect size	Outcomes
RQs on likelihood of use by young and older Chinese participants			
RO2c	0.98	small	No difference
RQ4c	0.99	small	No difference
RQs one expertise by young and older Chinese participants			
RO3c	0.86	small	No difference
RQ5c	0.88	small	No difference
RQ on “double standard” by young and older Chinese participants			
RO6e	0.55	small	No difference
RQ6f	0.82	small	No difference

The independent variables in the ANOVAs were: Device (within participant measure, 3 levels: desktop, laptop, smartphone), Target Person Age (between participant measure, 2 levels: Young, Old), Target Person Gender (between participant measure, 2 levels: woman, man), Participant Gender (between participant measure, 2 levels: woman, man), and Participant Age (between participant measure, 2 levels: Young, Old).

There was a significant interaction between Device and Participant Age with small effect size $F(2, 318) = 7.18$, $p < 0.001$, $\eta p^2 = 0.04$. Figure 3.14 shows that for young Chinese participants, there is a significant increase in the perception of the likelihood of use from desktops to laptops to smartphones (all comparisons significant a $p < 0.001$ However, for older Chinese participants, the likelihood of using smartphones is significantly higher than desktop computers or laptop computers ($p < 0.001$), but there was no significant difference between the likelihood of using desktop computers and laptop computers.

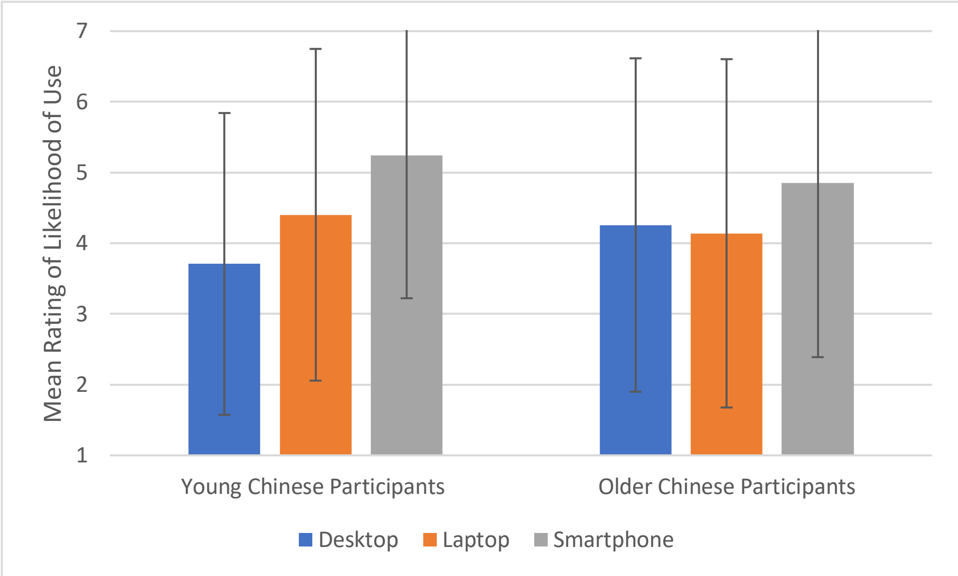


Figure 3.14: Mean ratings of likelihood of use for young and older Chinese participants for three devices

There is a three way interaction between Device, Target Person Age and Participant Age, but only with a small effect size: $F(2, 318) = 3.56$, $p = 0.03$, $\eta p^2 = 0.02$. Although both young and older Chinese participants thought that young target persons were more likely to use technologies than older target persons, the degree of difference varies with the device (see Figures 3.15 –3.17). Especially for laptop computers (Figure 3.16), young Chinese participants rated the young target person three times as much as the older target person, compared to a smaller gap in ratings given by the older Chinese participants.

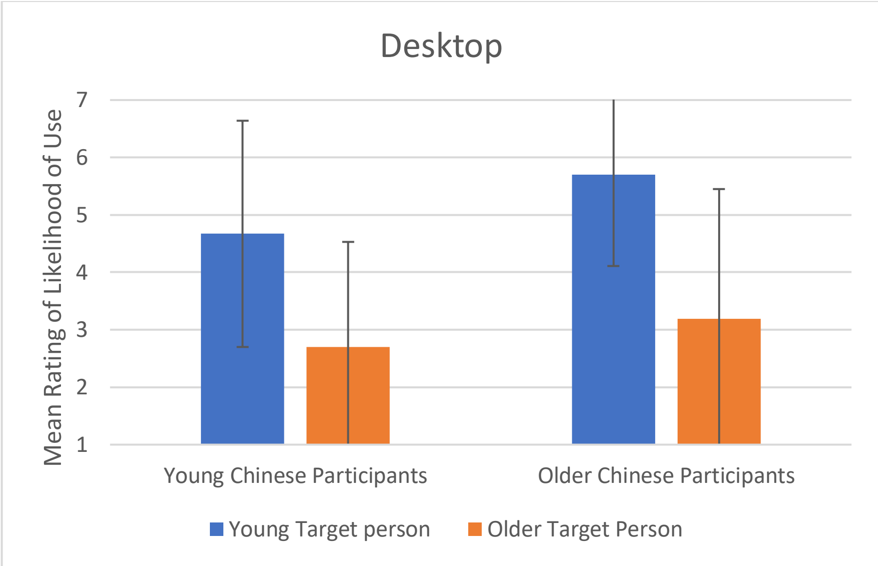


Figure 3.15: Mean ratings of likelihood of use for young and older target persons for desktop computers by young and older Chinese participants

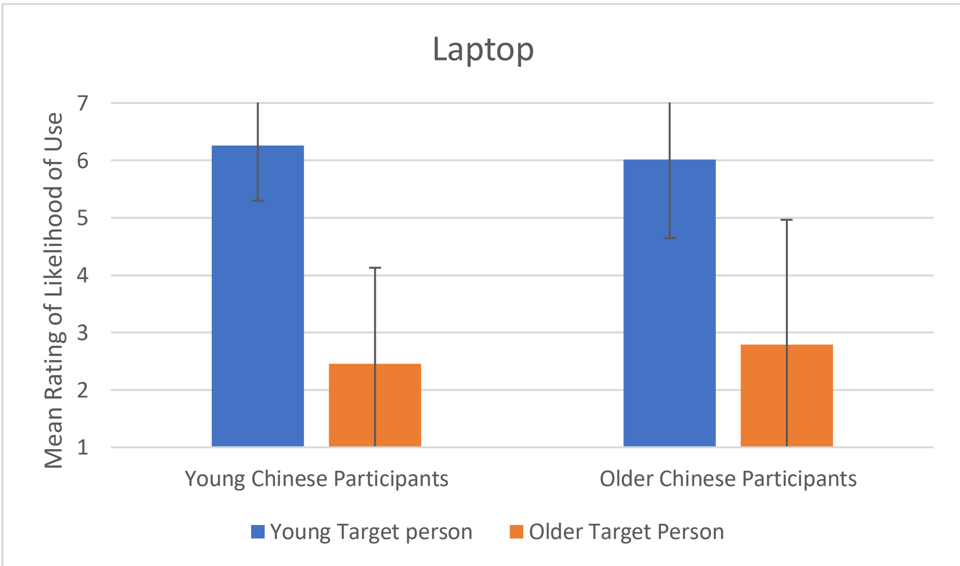


Figure 3.16: Mean ratings of likelihood of use for young and older target persons for laptop computers by young and older Chinese participants

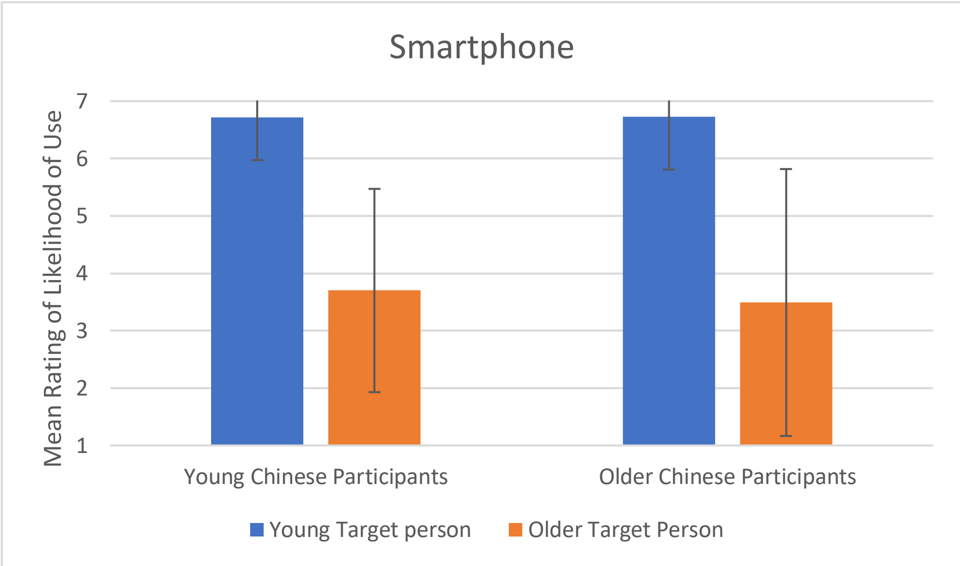


Figure 3.17: Mean ratings of likelihood of use for young and older target persons for smartphones by young and older Chinese participants

Finally, there was a significant three way interaction between Device, Target Person Gender and Participant Age with small effect size F (2, 318) = 3.78, p = 0.02, $\eta p^2 = 0.02$. Although both young and older Chinese participants gave a high rating on male target participants' likelihood of using technologies, but the degree of difference varies with the device (see Figures 3.18 – 3.20). For example, Figure 3.18 shows young Chinese participants gave obviously higher ratings on male target person's likelihood of using desktop computers, while older Chinese participants gave similar ratings on male and female target persons. But in terms of laptop computers, Figure 3.19 shows older Chinese participants gave obviously higher ratings on male target participants, while there is less gap in ratings between male and female target persons by young Chinese participants.

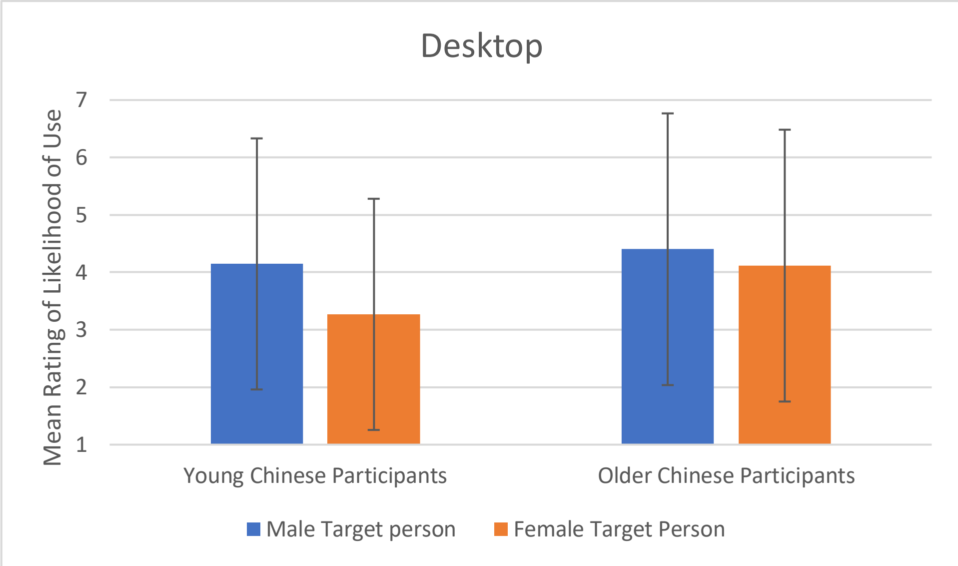


Figure 3.18: Mean ratings of likelihood of use for male and female target persons for desktop computers by young and older Chinese participants

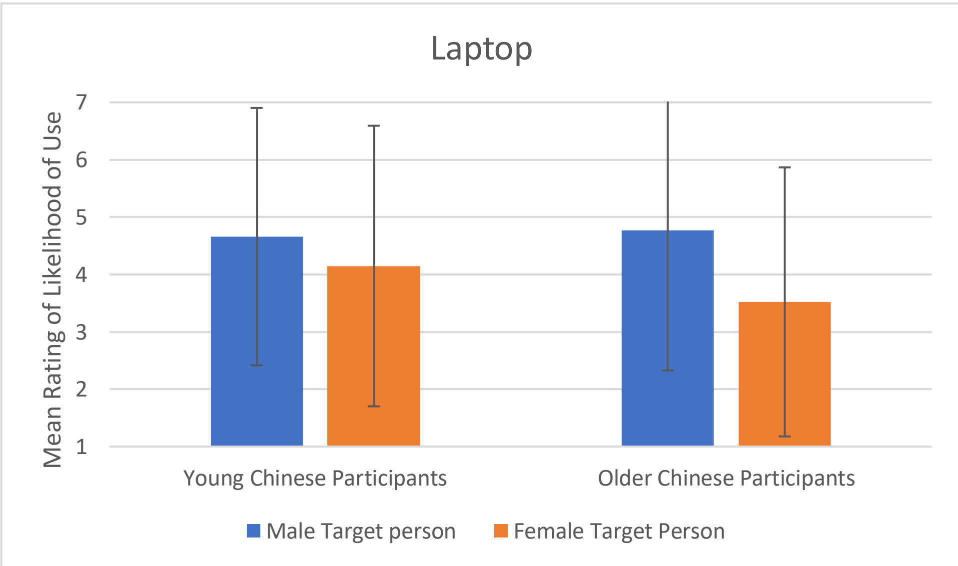


Figure 3.19: Mean ratings of likelihood of use for male and female target persons for laptop computers by young and older Chinese participants

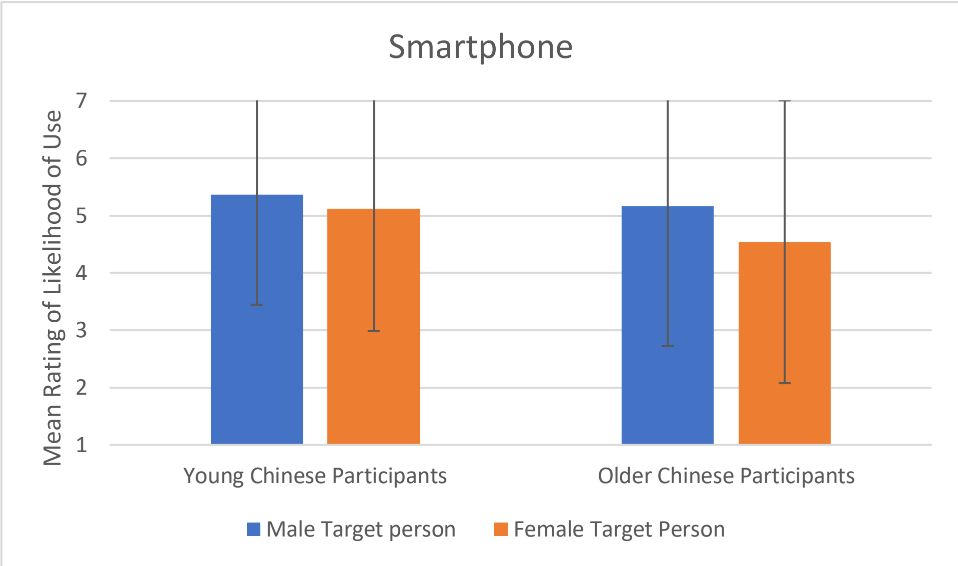


Figure 3.20: Mean ratings of likelihood of use for male and female target persons for smartphones by young and older Chinese participants

In the perception of the use of technologies, there were no other significant interactions and no main effect for Participant Age.

In terms to the expertise of using technologies, there was a significant interaction between Participant Age and Participants Gender with a small effect size $F(1, 159) = 4.032$, $p = 0.046$, $\eta p^2 = 0.025$. Figure 3.21 shows that young male Chinese technologists give a higher mean rating than older male Chinese participants on the expertise of all target persons on all devices, while female older Chinese participants give a higher rating than young female Chinese technologists.

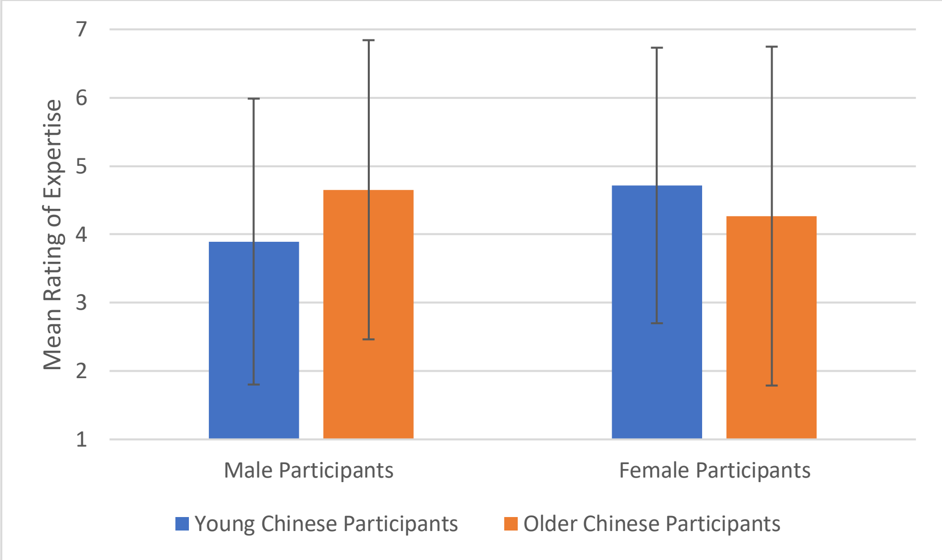


Figure 3.21: Mean ratings of expertise for all target persons on all devices by young/older and male/female Chinese participants

Next, there was a significant interaction between Device and Participant Age with small effect size F (2, 318) = 8.54, $p < 0.001$, $\eta p^2 = 0.05$. Figure 3.22 shows that for young Chinese participants, smartphones are significantly higher than desktop and laptop computers ($p < 0.001$), but there was no significant difference between desktop and laptop computers. However, for older Chinese participants, smartphones are significantly higher than laptop computers ($p < 0.001$), but there was no significant difference between other comparisons.

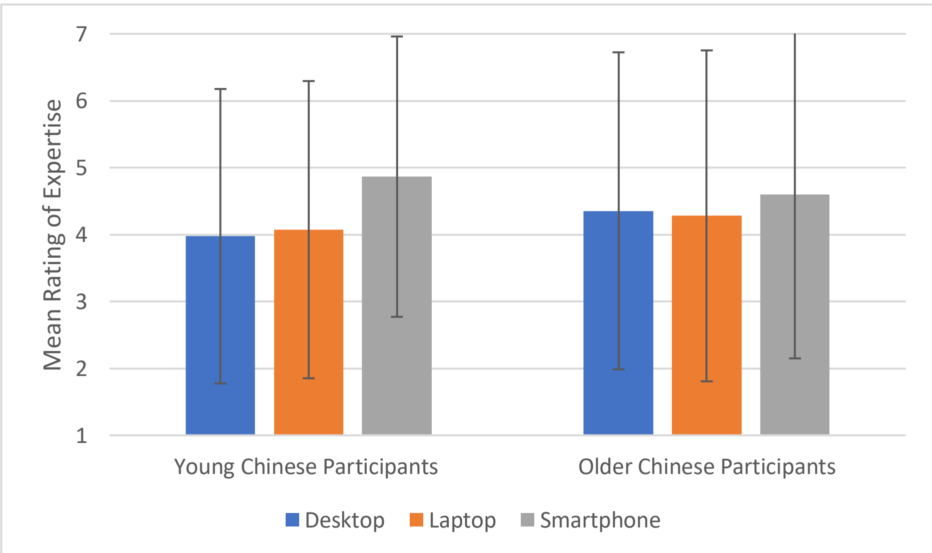


Figure 3.22: Mean ratings of expertise for three devices by young and older Chinese participants

Finally, there was a significant three way interaction between Device, Target Person Gender and Participant Age, but with small effect size again $F(2, 318) = 9.75$, $p < 0.001$, $\eta p^2 = 0.06$. This interaction is illustrated in Figures 3.23 – 3.25. Although young and older Chinese participants gave overall high ratings on male target person, young participants gave the same rating for male and female target person in their expertise in using smartphones, while older Chinese participants perceived a large different between male and female target persons (Figure 3.25). In contrast, in terms of the desktop computers (Figure 3.23), the ratings given by older Chinese participants show less difference between male and female target persons, while there was a large difference in ratings given by young Chinese participants.

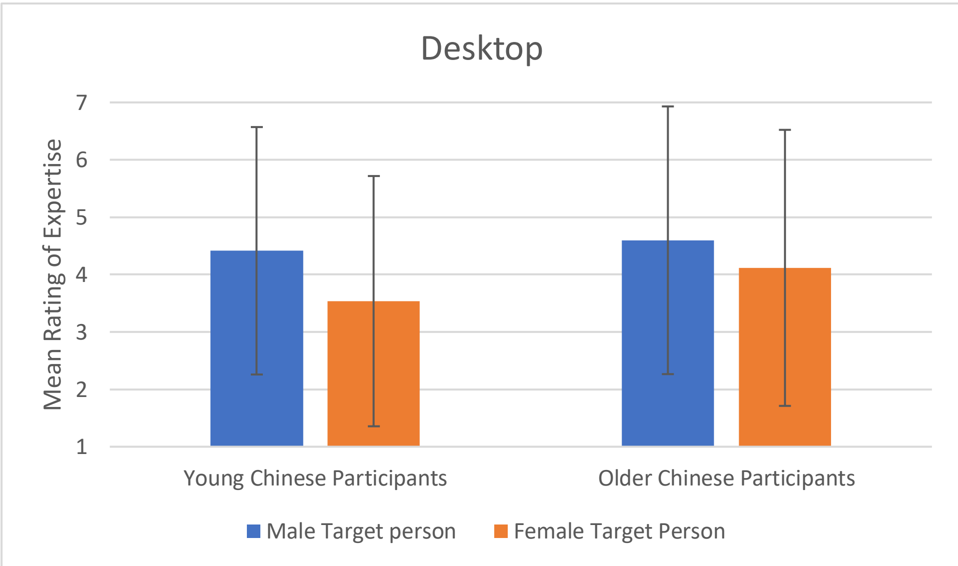


Figure 3.23: Mean ratings of expertise for male and female target persons for desktop computers by young and older Chinese participants

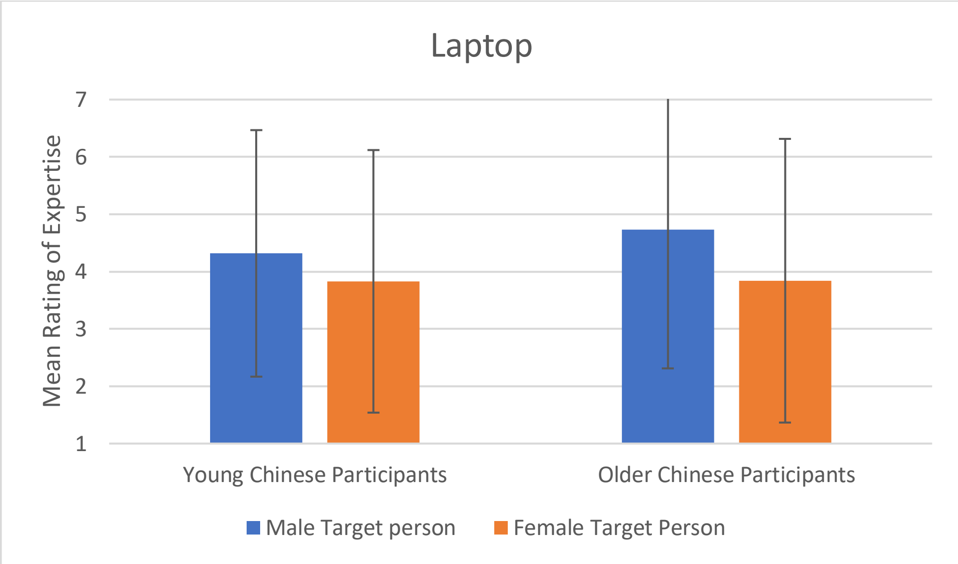


Figure 3.24: Mean ratings of expertise for male and female target persons for laptop computers by young and older Chinese participants

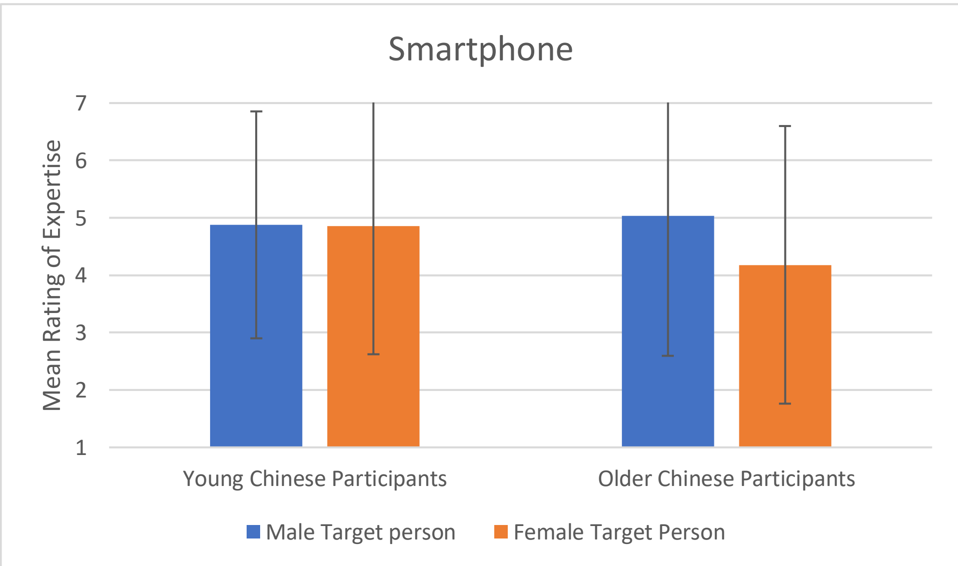


Figure 3.25: Mean ratings of expertise for male and female target persons for smartphones by young and older Chinese participants

In the perception of the expertise of using technologies, there were no other significant interactions and no main effect for Participant Age.

In summary, these results support RQ2c (Is there a difference between young Chinese technologists and older Chinese people in their attitudes to older and younger people as users of digital technologies?). Although the interaction between Target Person Age and Participant Age is not significant, when I add Devices, it is significant. But it is always the case that young participants think young people will be more likely to use digital technologies. The results also support RQ4c (Is there a difference between young Chinese technologists and older Chinese people in their attitudes to men and women as users of digital technologies?); the interaction between Target Person Gender and Participant Age is not significant in participant's perception of likelihood of using technologies, while it is significant when I add Device. The result also supports RQ5c (Is there a difference between young Chinese technologists and older Chinese people in their attitudes to men and women as experts in digital technologies?), the interaction between Target Person Gender and Participant Age is not significant in participants' perception of the target person's expertise in using digital technologies, but it is significant when Device was added. In contrast, RQ3c (Is there a difference between young Chinese technologists and older Chinese people in their attitudes to older and younger people as experts in digital technologies?), RQ6e (Is there a difference between young Chinese technologists and older Chinese people in their attitudes to older women as users of digital technologies?), and RQ6f (Is there a difference between young Chinese technologists and older Chinese people in their attitudes to older women as experts in digital technologies?) were not supported because the results were not significant.

3.4 Discussion

This study investigated sexism and ageism amongst young technologists and older people in China. On the first research question of the perception of when old age starts, the study investigated how young Chinese technologists and older Chinese people define older people and to identify whether there is a difference in their perceptions. Young Chinese technologists thought the minimum age was approximately 60 years. This matches the legal retirement age for men in China, which is 60 years, although it is 55 years for women. As I wanted to keep the questionnaire short and simple, I did not ask a separate question about when old age starts for men and women to see if there was a difference. However, there was no difference between young Chinese male and female technologists in their perception of when old age starts.

On the other hand, older Chinese people thought the minimum age was approximately 65 years. This is above the legal retirement age in China, which is 60 years for men and 55 years for women. Chinese women retire earlier than Chinese men, the majority of older female participants in the study have been retired for more than 5 years while many older male participants have been retired for just a few months, but there was no difference between male and female participants in their perception of the minimum age of older adults. Moreover, many older participants did not consider themselves as older people. Although society generally believes that they are older people, they do not think so themselves. They feel that they have good health conditions and cognitive, so many older Chinese participants do not think they are older people.

On the question of a difference between young Chinese technologists and older Chinese people in their perception of the minimum age when old age starts, this study found that young technologists and older Chinese people hold different views on the minimum age of older people. This difference may be due to the legal retirement age, the retirement age for Chinese women is 55 years, and that for men is 60 years. Young Chinese people were perhaps influenced by the statutory retirement age; they consider those who are retired as old people. However, with the development of society and progress in healthcare, people who retire still have rich and colorful lives and good health conditions. Under these circumstances, many older Chinese respondents in the study did not think of themselves as older people. Therefore, it seems biased to define older people by retirement age, and young Chinese technologists should be aware of this when they develop technological products for older people.

The second and third research questions in this study were to identify whether ageism amongst young Chinese technologists and older Chinese people. On the second research question of the attitudes to the use of digital technologies by young and old people, the study investigated ageism amongst young Chinese technologists and older Chinese people by comparing how likely young and older people are to use technologies. The study found that both young Chinese technologists and older Chinese people perceived older people as significantly less likely to use digital technologies than young people. Although young Chinese technologists and older Chinese people think that older people are less likely to use digital technologies, many older people use technologies nowadays, especially smartphones. In 2018, Tencent (a Chinese multinational technology and entertainment conglomerate and holding company) released data that WeChat users aged 55 to 70 reached 61 million[13]. In 2021, the UK 73% of people over 65 used the Internet through various technological products (Ofcom, 2022). Therefore, people should be aware that older people are also important users of digital technology products, although they may use less variety of digital technologies than young people.

Next, on the third research question of the attitudes to the expertise of young and old people in relation to digital technologies, the study examined ageism amongst young Chinese technologists and older Chinese people by comparing their attitudes to older and younger people as experts in digital technologies. The study found that young Chinese technologists and older Chinese people thought older people had less expertise in using digital technologies than young people. It can be seen that the older people themselves believe that they lack expertise in using digital technologies, not only young Chinese technologists. Therefore, it is worth paying attention to how to help older people improve their expertise in using technologies and then help them to build confidence in using them; at the same time, it is necessary to make technological products easier to use.

Thus, there is strong evidence of ageism among both young Chinese technologists and older Chinese people. This result supports those from previous studies (Petrie, 2018; Goriup & Lahe, 2018; Mohammed & Omar, 2019), that young people hold negative attitudes and beliefs about older people. The British young computer science undergraduates studied by Petrie had negative attitudes toward older people in comparison to young people. The Slovenian students studied by Goriup and Lahe (2018) had a lack of knowledge about aging and held negative attitudes toward older people. In addition, nursing students in Egypt, lacked knowledge about elderly care and had negative attitudes towards older people. Finally, these findings suggest that there has ageism among old Chinese people, which has not previously been described.

This study's fourth and fifth research questions were to identify whether sexism amongst young Chinese technologists and older Chinese people. On the fourth research question of the attitudes to the use of digital technologies by women and men, the study investigated

[13] URL information from website: https://tech.qq.com/a/20181016/013129.htm

sexism among young Chinese technologists and older Chinese people by comparing how likely men and women are to use technologies. The study found that both young Chinese technologists and older Chinese people perceived no significant difference between men and women in their likelihood of using digital technologies. Then, on the fifth research question of attitudes to the expertise of women and men in relation to digital technologies, the study examined sexism among young Chinese technologists and older Chinese people by comparing their attitudes to men and women as experts in digital technologies. The study found that young Chinese technologists and older Chinese people hold the same attitudes toward men and women in their expertise in using digital technologies.

Therefore, there was no evidence of sexism among young Chinese technologists and older Chinese people. This outcome is different from that of Petrie (2018), who found no significant difference in the likelihood of using the three technologies between the genders, but that women were perceived as less expert with the technologies than men by British computer science undergraduates. On the other hand, what is surprising is that there is no sexism among older Chinese people; they hold the same attitudes toward men and women. This difference deserves attention and reflection from young technologists, especially when designing technological products for older people in the future.

The final research question of the "double standard" about older women, the aims of this question sought to determine whether it exists by comparing young Chinese technologists' and older Chinese people's attitudes to older women in comparison to older men and younger men and women. It was only found that older women were perceived as less likely to use digital technologies in comparison to older men and younger men and women by young Chinese technologists, there was no evidence of a “double standard” in the perception of expertise. Thus, while this study found a “double standard” in attitudes and beliefs about older women by young Chinese technologists, but there was no evidence of a “double standard” in Petrie’s study; British computer science undergraduates do not have a “double standard” for older women. In contrast, there was no evidence of a "double standard" from older Chinese participants, which is different from young Chinese respondents. These results are likely to be related to slight sexism among young Chinese technologists; thus, they have a "double standard" about older women. Likewise, there was no sexism among older Chinese people; thus, there was no "double standard" about older women.

In addition, the study produced some other interesting findings. The most obvious finding to emerge from the analysis is that both young Chinese technologists and older Chinese people thought all target people, regardless of age or gender, were more significantly likely to use and be more expert in using smartphones than laptop and desktop computers. These results may be explained by the fact that smartphone users have increased in recent years, and smartphones have also become an indispensable part of people's daily lives. However, young Chinese technologists and older Chinese people hold different views on the likelihood and expertise of using laptop and desktop computers. Young Chinese technologists thought all target people, regardless of age or gender, were more likely to use and be more expert in using laptop computers than desktop computers. In contrast, older Chinese people thought all target people, regardless of age or gender, were more likely to use and be more expert in using desktop computers than laptop computers. This inconsistency may be due to young Chinese technologists using laptop computers more in their daily lives, while older Chinese people usually use desktop computers. This difference is also worth noting to young Chinese technologists; despite portable digital devices becoming more popular and widely used among young people nowadays, they might not be widespread among older people except smartphones.

3.5 Conclusions and future work

The main goal of the current study was to determine the attitudes of young Chinese technologists and older Chinese people in their perceptions of various aspects of ageism and sexism in relation to the use of digital technologies. The study found that young and old Chinese people have ageist attitudes about older people as users of technology; they hold negative attitudes towards older adults compared to young ones as both users of and experts in technology. In addition, the study found that young Chinese technologists and older Chinese people hold the same attitudes toward men and women as users of and experts in technology. However, although young Chinese technologists did not have sexist attitudes about women, they have a 'double standard' for older women as being perceived negatively in the likelihood of using technologies compared to old men and young women.

The study identified that young and old Chinese people hold differing views on the minimum age of older people; young Chinese people thought that adults over 60 years as older people, but old Chinese people thought older people should be aged over 65 years. These differences deserve attention, especially in the future, when young technology developers design products for older people.

The study used a quick and simple method for assessing ageism and sexism about technology use and expertise. It is unfortunate that the study did not include qualitative research, but I wanted to keep the study very short and simple, in order to collect a large number of responses. It is also possible that if participants start to think about the issues too carefully, they may give more socially desirable answers. However, this means that deep reasons for people's attitudes have not been explored in this research. This is a preliminary study on investigating Chinese young and older people's ageist and sexist attitudes about people as users of technology; therefore, I wanted the study to have a large sample size that can get their attitudes in general, quantitative methods is a useful way to understand Chinese people's attitudes. But, the reasons which cause ageism and sexism are still worth exploring in the future. Further work needs to validate this method against other ways of measuring these variables. Nonetheless, this can be an interesting exercise to conduct with students or work colleagues to initiate a discussion about the issues around ageism and sexism in perceptions of use and expertise with technologies and how to address these issues.

The present study provides the first comprehensive assessment of young Chinese technologists and old Chinese people's attitudes toward older adults using and expertise with modern technologies. Furthermore, this study supports Petrie's (2018) study on the ageist attitudes about people as technology users. But the results from the current study shows different views in sexist attitudes about technology users. The reasons for the different attitudes of Chinese and British young computer scientists are still unanswered, and it is worth exploring in future work.

With the rapid growth of the Chinese aging population, many older people do not know how to access the Internet or use technology products. They encounter inconveniences in daily life, such as medical treatment, shopping, and other scenarios. Also, they cannot fully enjoy the convenience brought by online services. This issue has attracted the attention of the Chinese government and society. Many mainstream media in China have reported that older Chinese people face many difficulties because they do not know how to use digital technology products, which in order to attract the attention and help from society[14 15]. Especially after the coronavirus pandemic, it is inconvenient to travel without a health QR code, it is hard for medical treatment without an online appointment in advance, and there are many obstacles to consumer payment. Besides, the government has also introduced a number of policies to solve the problem of older people's difficulty in using digital technology, such as adapting websites and APPs for older people's use[16 17]. People will rely more on technology with the development of society and technology. Although young Chinese scientists have negative attitudes towards older people using digital technology products, they should realize that older people will also become important users of these products. Therefore, young people should understand that older people need to use digital technologies, and young technologists should help older people use such products easily and efficiently. In addition, it is particularly important that young Chinese people involved in technology development do not have negative attitudes towards older people and women using technology products. Therefore, positive education is needed to address this issue in both Europe (building on Petrie's results) and China.

[14]URL information from website: http://www.xinhuanet.com/politics/2020-12/06/c_1126826355.htm
[15]URL information from website: http://health.people.com.cn/n1/2022/0302/c14739-32363252.html
[16]URL information from website: http://www.gov.cn/zhengce/content/2020-11/24/content_5563804.htm
[17]URL information from website: http://www.gov.cn/xinwen/2021-08/19/content_5631990.htm

Chapter 4: Study 2: Investigation of older Chinese people’s use and attitudes to digital technologies and robots

4.1 Introduction

With the aging population and the development of technology, older people have become important technology users who cannot be ignored. Technology that is developed for older people might be different from that for young people because of the different needs and wishes of older people. However, Study 1 found that young Chinese technologists hold negative attitudes towards older adults as both users of and experts in technology. In addition, although young Chinese technologists did not have sexist attitudes about women, they have a 'double standard' for older women as being perceived negatively in the likelihood of using technologies compared to old men and young men and women. Therefore, young technologists might not fully understand older Chinese people's use of and attitudes to digital technologies and robots. In these circumstances, it is important to understand the use, behaviour, purposes, and experience of older people in using technologies in their daily lives. This will contribute to designing technologies tailored appropriately for older people and improving their user experience. In addition, it is also important to understand the attitudes of older people toward technology, which will directly affect their willingness to use these technologies.

To date, as mentioned in literature review (see Chapter 2), many studies have investigated older people’s technology use, and found that older people use a wide range of technologies to make their lives easier, and communicate with others. These include technologies such as smartphones, computers, and tablets (Chan and Chen., 2016; Fausset, Harley, Farmer, and Fain, 2013; Mitzner et al., 2010; Quan-Haase., 2018; Vaportzis et al., 2017; Wang et al., 2019). However, with the rapid development of science and technology, especially in the current era of rapid development and popularization of AI technology, the technology products used by older people in their daily lives are no longer just computers and smartphones. Contemporary older people are also likely to use technology products with AI technology. Additionally, those studies mainly focus on Western countries, with limited attention given to the Asian region, except a study investigated older Chinese people’s acceptance of smartphones (Chan and Chen., 2016). Thus, this study aims to comprehensively investigate the technology use and user experience of older people in China in their daily lives.

The study will also explore older Chinese people’s attitudes toward new technologies and robots, especially considering the rapid development of artificial intelligence (AI) and many technology products now incorporating AI technology. I will take the definition of attitudes provide by Albarracin and Shavitt (2018) that the attitude is “a person’s evaluation of an object on a favourable to unfavourable continuum” (p300). Attitudes can be expressed directly, if participants are asked to express their attitude towards something, but in a semi-structured interview, participants may often express their attitude indirectly, commonly known as an implicit expression (Albarracin & Shavitt, 2018). For example, a participant said which is implicit expression of the positive attitude because she was responding to my question about good experiences, “I can watch the news at any time on my smartphone, which is different from TV, some TV programs have to be watched at a specific time” (P16). On the other hand, sometimes, participants expressed the positive attitude directly “It's all good; I can't leave my smartphone right now” (P10).

As this study was conducted during the COVID-19 pandemic, it also explored older Chinese people’s digital technology use and attitudes in the context of the pandemic.

More specifically, the study investigated the following research topics and questions:

Topic 1. Digital technology and older Chinese people - Pre-COVID-19 pandemic

RQ1a. Pre-pandemic, what digital technologies did older Chinese people use in their daily lives?

RQ1b. Pre-pandemic, what did older Chinese people use these digital technologies for?

RQ1c. Pre-pandemic, what were older Chinese people’s attitudes to using digital technologies in their daily lives?

Topic 2. Digital technology and older Chinese people - during the COVID-19 pandemic

RQ2a. During the pandemic, what digital technologies did older Chinese people use in their daily lives?

RQ2b. During the pandemic, what did older Chinese people use these digital technologies for?

RQ2c. During the pandemic, what were older Chinese people’s attitudes to using digital technologies and did they change as a result of the pandemic?

Topic 3. Issues about new technologies for older Chinese people Pre and during the COVID-19 pandemic.

RQ3a. What are older Chinese people's general attitudes to new technologies?

RQ3b. What factors affect older Chinese people's decisions to use new digital technologies?

RQ3c. How do older Chinese people learn to use their digital technologies?

Topic 4. Robots and older Chinese people

RQ4a. Are older Chinese people aware of personal robots and their possibilities?

RQ4b. What are older Chinese people's attitudes to personal robots?

RQ4c. What are older Chinese people's preferences for different personal robot types (i.e. companion pet or task-oriented robots)?

RQ4d. What are older Chinese people’s expectations of personal robots?

RQ4e. What are older Chinese people's concerns about personal robots?

4.2 Method

4.2.1 Design

The study investigated older Chinese people’s use of and attitudes towards digital technologies. A semi-structured interview approach was chosen because it allows a deeper insight into the participants’ ideas and opinions. Due to the special circumstances of the COVID-19 pandemic, the interviews had to be conducted online via WeChat (a Chinese instant messaging, calling, social media, and mobile payment app).

As discussed in the Design of Study 1 (see Chapter 3, section 3.2.1), this study used the United Nations definition of older people, who are defined as over 60 years old (UN, 2022). In addition, Study 1 found that in general young Chinese participants thought of people over 60 years as older people. Because the study was conducted online, it focused on older Chinese people living in urban areas, as they are more likely to access the Internet and use digital devices capable of video calls. In addition, older participants were also required to meet the criterion of being retired. Therefore, the inclusion criteria for participation in the study was to be an older Chinese person, defined as at least 60 years old, retired and living in an urban area.

A five-section schedule was used in the semi-structured interviews. The first section was an introductory section, which enabled me to get to know the participants. The second section explored older Chinese people's use and attitudes towards digital technologies before the COVID-19 pandemic. In this section, the study also investigated their general attitudes to new digital technologies that they have not used. Although I asked them about their attitudes toward new technologies before the COVID-19 pandemic, because the interviews were conducted during the COVID-19 pandemic, participants very often answered about the current situation during the pandemic. Thus, the study explored their current general attitudes to new technologies. In the third section, to identify the effect of the pandemic on older Chinese people's attitudes to and use of digital technologies, participants were asked how their use of digital technologies changed during the COVID-19 pandemic and their opinions of any changes. In the fourth section, participants' knowledge, attitudes, expectations, and concerns about using personal robots were discussed. As in the second section, the original idea had to ask them about their attitudes toward personal robots before the COVID-19 pandemic; because the interviews were conducted during the COVID-19 pandemic, participants always answered about their current perceptions of robots. Thus, their current perceptions about using personal robots were explored in this section, meaning those during the pandemic. In the final section, the participants' demographic information was collected.

4.2.2 Participants

Snowball and opportunistic sampling methods were used in participant recruitment. I first searched for participants who met the inclusion criteria whom I knew and asked if they would like to participate in the study (i.e. opportunistic sampling). Then through these participants, I asked them if they knew anyone else who met the criteria and would like to participate (i.e. snowball sampling). Potential participants were contacted through the WeChat message service and asked if they would participate in the study.

25 older Chinese people who met the inclusion criteria participated in the study. Participants' average age was 63.28 years (SD: 2.75), with a range from 60 to 69 years old. 13 were women, and 12 were men. On average, they had been retired for 8.72 years (SD: 6.62), with a range from 1 to 22 years. Participation was voluntary, and participants were not offered any reward.

4.2.3 Apparatus

The interviews were conducted via WeChat, which is a Chinese instant messaging, calling social media, and mobile payment app. The interviews were recorded using an iPad voice recording system for later analysis.

4.2.4 Interview Schedule

All documents were prepared in English and afterwards I translated them into Chinese and they were checked by another native speaker of Chinese (another Ph.D. student at the University of York), who is fluent in English and Chinese.

The first section was an introductory section to relax the participants and allow me to get to know them. This section included general questions about the interviewee's day, their daily life, and how it changed due to the COVID-19 pandemic. Then, I brought the conversation to everyday digital technology use, and the main sections of the interview then followed.

The second section was about older Chinese people's use and attitudes toward digital technologies that they used in daily lives. Firstly, I explored which digital technologies were used by older Chinese people in their daily lives, their reasons for using them, and their experiences of using them. Then, their learning experiences with digital technologies was investigated, participants were asked about how they learned to use digital technologies and their experience of learning to use them. Finally, their general attitudes toward new technologies were investigated. Participants were asked how they decided to use new technologies, and their attitudes to using them. Both open-ended and rating questions were asked during this part, in order to help me understand the participants' daily use of digital technologies and their attitudes toward digital technologies. For example, I asked participants, "What did you use of these technology products for?" and "What is/was good about using technologies."

The third section was about older Chinese people's use and attitudes towards digital technologies that they used during the COVID-19 pandemic. First, I explored which digital technologies were used more by older Chinese people during the COVID-19 pandemic than previously, their reasons for using them, and their experiences of using them. Then, I investigated their feelings during the COVID-19 pandemic, for example, whether they got bored or lonely when they had to stay home during the lockdown periods. Open-ended questions were asked during this section, and the order of discussion of each of the themes varied, depending on the participants' train of thought. For example, I asked participants, “Did you rely more on the technologies you mentioned above than usual?”

The fourth section was about older Chinese people's attitudes and expectations about using personal robots. First, I investigated their general knowledge about personal robots and whether they had seen or used them. Then, I introduced two personal robot types, task-oriented robots and social companion robots. I gave general information and functions of these two robot types (Table 4.1). For example, how task-oriented robots could help older people at home, and how social companion robots could accompany older people and have emotional reactions when they interact with them. After that, I explored participants' preferences for these two robot types, their attitudes to using personal robots at home, and their expectations and concerns about using personal robots. Open-ended questions were asked during this section. For example, I asked participants, “Would you be willing to have robots help you in the home?”

Participants' general demographic information was collected in the final section, such as their gender and age.

The full interview schedule is given in Appendix D.

Table 4.1 The introduction of companion robots and task-oriented robots

Robot types	Purpose	Appearance	Functions
Companion robots	The primary purpose of companion pet robots is to enhance the well-being and happiness of their owners. They can provide comfort and alleviate feelings of loneliness, especially in situations where human interaction might be limited. Additionally, these robots can serve as therapeutic aids for individuals	Companion robots come in various shapes and sizes, but they are often designed to resemble real animals, such as dogs, cats, or other beloved pets.	Emotional interaction Physical interaction Autonomous behavior Therapeutic support Customization, Sensory features...

	dealing with stress, anxiety, or certain medical conditions.		
Task-oriented robots	Task-oriented robots are designed to perform specific tasks or functions to assist and enhance human activities in various settings. The primary purpose of task-oriented personal robots is to simplify daily routines and improve the quality of life for individuals. They are intended to be companions that help with various household chores, communication, and even provide entertainment.	Task-oriented robots come in diverse shapes and sizes, depending on the specific function they are designed to perform. Their appearance is usually functional and optimized for the task at hand. Some robots may be small and compact, while others may be larger and more complex, depending on the requirements of the job.	Household chores, Personal assistance (reminder, answer questions…) Entertainment (playing music, videos, and interactive games...) Security (surveillance cameras and remote monitoring) Elderly and disabled Assistance….

4.2.5 Pilot study

A pilot study was undertaken before starting the interviews. Two participants took part in the pilot study. Both were aged 59, a retired female participant, and a semi-retired male participant. Although they did not quite meet the inclusion criteria for the study, it was assumed that they were close enough to the target group that they would be able to identify any problems in the interview schedule. In the initial schedule, the participants were to be presented with photographs of the two different types of robots to illustrate them. However, both participants thought that doing the online interview and simultaneously presenting photographs was too complicated. Because older people are not experts at using technology, sending photographs of robots to the participants during the interview and then keeping the video call on while they looked at photographs, would be too complicated for them. Thus, the photographs presented were replaced by my verbal descriptions. Therefore, one aspect of the interview schedule was revised based on the pilot study results: the photograph presentation was replaced by verbal explanations of the two different types of robots.

4.2.6 Procedure

Full ethics approval was obtained from the ethics committee of the Computer Science department of the University of York (Approval number - Chen20200622).

Potential participants were contacted through the WeChat message service, and asked which time was available; then, a time slot for the interview was scheduled.

At the start of the WeChat session, the interview started with building rapport, I introduced myself, such as what my PhD was about. Then, I sent the participant an information sheet detailing the study and what they would be asked to do and an informed consent form. They had a chance to ask questions before signing the informed consent form. They were also asked permission to record the interview. Next, they were also asked to complete the informed consent form showing they understood and consented to be part of the study (see Appendix C). Participant data in the study was anonymous, and each participant was assigned a code number. Participants could ask questions at any time or withdraw from the study, I would delete their data using their code if they wanted to withdraw from the study.

The formal interview started with introductory section to relax the participants and get to know them. The three main sections of the interview followed. First, I investigated their use and attitudes toward digital technology products they use daily and explored their attitudes toward the new technologies that they haven't used before. Next, we discussed the digital technology products that were used in the COVID-19 pandemic and their experience of using them. Then, I explored their knowledge, attitudes, expectations, and concerns about using personal robots. Participant demographic information was collected after completing the main sections of the interview.

Each interview took approximately half an hour. All interviews were conducted in Chinese, the native language of the participants.

4.2.7 Data preparation and analysis

The interviews were voice recorded. I precisely transcribed each recording and translated it into English.

Two analytical methods were used in this study, which are content analysis (Schreier, 2012) and thematic analysis (Braun and Clarke, 2006). For example, for RQ1a, content analysis was used to explore what digital technologies participants used and their purposes. For RQ1b, thematic analysis was used to investigate participants' attitudes toward digital technologies.

The content analyses followed the following steps:

- selecting relevant material from the interview data by identifying the portions of the data that are relevant to the research question;
- building a coding frame by categories that are used to organize the data; dividing material into units of coding;
- testing the coding frame by coding a sample of material from transcription to see whether the codes were sufficient;
- evaluating and modifying the coding frame according to the results of the testing; coding all the material by applying the coding frame to all the relevant material in the data set.

For example, a content analysis was used to create 5 levels of difficulty of participants learning to use technologies, which are “Very easy”,” easy”, “Neither easy nor difficult”, “Difficult”, and “Very difficult”. I was looking at the words that participants used. In one case, a participant (P13) said: “learning to use smartphones is very hard.” Then, the difficulty level of the participant in learning to use smartphones was categorized as “Very difficult.”

The thematic analyses followed the following steps:

- familiarizing myself with data by thoroughly acquainting myself with the data by reading and listening to it multiple times;
- generating initial codes by labels that capture interesting contents and features within the data;
- searching for themes by reviewing the initial codes, and searching recurring ideas across the data;
- reviewing themes by reviews and refines the identified themes by organizing related codes under each theme;

- defining and naming themes by its content and given a descriptive name that captures its essence.

Numeric data from the study also included data suitable for parametric and non-parametric analysis. I checked the ratings for whether they met the requirements for parametric analysis before I did further statistical analysis, and the results met the requirements for parametric analysis. Analysis of variance (ANOVA) was used to analyse the results of rating questions; chi-square goodness of fit test was used to analyze the result of categorical data.

4.3 Results

4.3.1 Topic 1: Digital technology and older Chinese people - Pre-COVID-19 pandemic

RQ1a investigated digital technologies used by older Chinese people in their daily lives before the COVID-19 pandemic and what their purposes were. Content analysis was used to analyse which digital technologies participants used in their daily life and their purposes.

Tables 4.2 and 4.3 summarise the digital technologies used by participants in their daily lives. All the participants (25, 100%) said that they used smartphones every day. 13 (52.0%) of participants mentioned that they used computers (covering both desktop and laptop computers). What is surprising is that 8 (32.0%) of participants reported that they used vacuum cleaner robots to clean their homes. Another unanticipated finding was that only a small number of participants (7, 28.0%) indicated that they watched television to see the news, TV series, their own videos, etc. In addition to these digital technologies mentioned by many participants, there are also some other digital technologies mentioned by only a few of them. Several participants (2, 8.0%) indicated that they used smart plant lights to take care of their plants. Two participants also indicated that they used voice controllers (i.e. a technology that could control household appliances, that allows users to interact with and manage various smart appliances and devices in their home using voice commands, similar to Amazon Alexa) at home. Tablet computers, electronic keyboards, and eReaders were mentioned by one participant each (4.0%).

In terms of the purposes for using digital technologies, eleven themes emerged in a thematic analysis of participants' answers (Table 4.2). The most common purpose was contacting family and friends using smartphones or computers ("Contacting others"), mentioned by all participants. All the participants mentioned that they usually connected with others through WeChat. One participant said:

> I communicated with my friends and family through smartphones. I use WeChat to share interesting pictures and make voice calls (P18, female, 61 years old)

Another common purpose was "Information access", mentioned by 22 (88.0%) participants. They usually browsed or watched the news using smartphones, computers, and televisions. They also searched for the information they needed on the Internet using smartphones and computers. One participant commented:

> I browsed the news online. Also, I searched for information through Baidu[18] when I encounter problems that I didn't understand, then I checked with Baidu (P12, female, 69 years old)

Using smartphones and computers for "Shopping and payments", both online and offline shopping (payments for shopping in shops), and payments was mentioned by 18 (72.0%) participants. They used digital technologies for grocery shopping, food deliveries, taking a taxi. One participant said:

> I used my smartphone to make a payment outside, shop online, make an appointment in the hospital, buy a group purchase and food delivery, etc. (P3, female, 60 years old)

"Entertainment" as a purpose was mentioned by 11 participants (44.0%). This included playing music, browsing social media, singing songs, etc. One participant commented:

> I used my smartphone to play music and story for my grandchildren. (P9, male, 63 years old)"

In addition to the above purposes mentioned often by the participants, there were also some purposes mentioned frequently by the participants, such "Working" and "Cleaning".

[18] Baidu: a search engine similar to Google

Table 4.2: Definitions of the themes relating to purposes of use of digital technologies for older Chinese participants

Theme	Definition	Example quotes
Contacting others	Call or text others to keep in touch (mainly via WeChat)	I communicated with my friends and family through smartphones. I use WeChat to share interesting pictures and make voice call. (P18)
Information access	Online information query or browse news	I browsed the news online. Also, I search for information through Baidu when I encounter problems that I didn't understand, then I checked with Baidu. (P12)
Shopping and payments	Online shopping (Buy daily necessities online, grocery shopping, ordering food delivery online, etc.) and offline mobile payment (Eat, shop, and take a taxi, etc.)	I used my smartphone to make a payment outside, shop online, make an appointment in the hospital, buy a group purchase and food delivery, etc. (P19)
Taking photos	Take pictures by using technology devices (mainly via smartphone)	I used to take pictures with my smartphone. (P14)
Booking	Online booking and making an appointment (train tickets, hospital appointments, etc.)	I used my smartphone to order train tickets. (P3)
Voice control	Using a voice control platform (such as Xiaomi and Xiaodu) to operate other appliances at home.	Voice control of home appliances, such as switching TV, air conditioner. (P17)
Entertainment	Using technologies to achieve entertainment purposes. (playing music, browsing social media, etc.)	I used my smartphone to play music and story for my grandchildren. (P9)
Cleaning	Using technology devices to clean the home (sweeping, mopping, etc.)	I swept the floor with a robot vacuum. (P24)
Doing Technology-mediated tasks	Use software to do something, mainly with computers (photos	I used the computer to do something; for example, some

	editing, stock trading, writing articles, etc.)	photos need to be stored and modified, and writing something. (P3)
Hard disk	Use smartphones or computers as hard disks, or use cloud storage; then, store photos or files in it.	I stored pictures on my computer and edited them into digital albums. (P18)
Working	Do some work-related things, mainly computers (such as sending and receiving emails, using professional software, etc.)	I used it a lot at work, such as looking at architectural drawings, writing documents, sending emails, and receiving and sending pictures. (P4)

Table 4.3: Use and purposes of digital technologies by Older Chinese participants' pre the COVID-19 pandemic

Purpose	Digital technology								
	Smartphone	Computer	Vacuum robots	Television	Plant light	Voice controller	Tablet computer	Electronic keyboard	eReader
All purposes	25	13 (52.0%)	8 (32%)	7 (25%)	2 (8%)	2 (8%)	1 (4%)	1 (4%)	1 (4%)
Contacting others N = 25	**25**	**1**	--	--	--	--	--	--	--
Information access N = 22	**19**	**9**	--	**5**	--	--	--	--	--
Shopping and payments N = 18	**17**	**1**	--	--	--	--	--	--	--
Taking photos N = 3	**3**	--	--	--	--	--	--	--	--
Booking N = 2	**2**	--	--	--	--	--	--	--	--
Voice control N=1	--	--	--	--	--	**1**	--	--	--
Entertainment N = 11	**7**	**4**	--	**3**	--	--	--	--	**1**
Cleaning N = 8	--	--	**8**	--	--	--	--	--	--
Doing Technology-mediated tasks N = 5	--	**5**	--	--	--	--	--	--	--
Hard disk N = 4	**1**	**3**	--	--	--	--	--	--	--
Working N = 3	**1**	**3**	--	--	--	--	--	--	--

RQ1b investigated the attitudes of older Chinese people toward using digital technology products in their daily life before the pandemic. Two questions were asked separately to investigate the attitudes of older Chinese people toward technology during the interviews. One question was about good experiences and the advantages of using technologies. The other question was about bad experiences and disadvantages of using technology, and their concerns of using technologies. Thematic analysis was used to analyse participants' attitudes in this area. These positive and negative themes will be discussed separately in detail below.

In response to the question about good experiences and advantages of using technologies, four themes emerged from (Table 4.4): "General characteristics," "Provide access to specific services," "Device attributes," and "Positive emotional reactions." For the theme of " General characteristics", there are five sub-themes. The two most frequently occurring sub-sub-themes were "Convenient" and "Provide specific functions." Participants mentioned that smartphones and computers have many useful functions that bring convenience to their lives, such as cameras and print functions on devices. For the theme of "Provide access to specific services", there were six sub-themes emerged from analysis. The sub-themes of "Information access", "Contacting others", and "Payments" were the most frequently occurring. Participants mentioned that the WeChat (a Chinese instant messaging, social media, and mobile payment app) and Baidu (a Chinese search engine) make it easier for them to contacting others, information access, and support their daily lives. For the theme of "Device attributes", five sub-themes emerged. The sub-themes of "Portable" and "Screen size" occurred the most. Finally, for the "Positive emotional reactions" theme, there were no sub-themes. Participants mentioned that digital devices had become a part of their lives, especially smartphones.

Table 4.4: Thematic analysis of older Chinese participants' positive attitudes towards digital technologies

Theme	Sub-theme	Example quotes
General positive characteristics (21, 84.0%)	Convenient (19,76.0%)	It's very convenient to go out and take pictures. (P11)
	Provide specific functions (9, 36.0%)	Computer editing functions are more convenient than

		smartphones, such as text input and file downloading. (P11)
	Available all the time (4,16.0%)	I can watch the news at any time on my smartphone, which is different from TV, some TV programs have to be watched at a specific time. (P16)
	Multifunctional (3,12.0%)	The function of the smartphone is very comprehensive, such as camera, mobile pay, shopping. (P10)
	Helps with poor eyesight (2,8.0%)	The computer screen is large; compared with smartphones, it is not as harmful to the eyes as smartphones. (P22)
Provide access to specific services (16,64%)	Information access (9,36.0%)	I can check accommodation and travel information through Baidu when I go out. (P7)
	Contacting others (7, 28.0%)	Communicating with family and friends is convenient; a family chat group has been established, and everyone will know when I send a message to the group (WeChat). (P19)
	Payments (7, 28.0%)	Mobile payment is convenient. I don't need to take cash to go out, and I don't need to go to the bank to withdraw money (P3)
	Online shopping (3,12.0%)	Online shopping is convenient, I don't need to go out, and the price of online shopping is low. (P23)
	TV (3,12.0%)	Watching TV can be used to understand current affairs and news. (P2)

	Entertainment (1,4.0%)	Watching TV can be used for entertainment purposes. (P2)
Device attributes (8, 32.0%)	Portable (3,12.0%)	Smartphones is also convenient to carry (P15)
	Screen size (3,12.0%)	The television's screen is big, which is enjoyable to watch (P3)
	Device size (1,4.0%)	The laptop is compact and convenient. (P24)
	Flexibility of display (1,4.0%)	The content on the computer screen can be zoomed in and out. (P13)
	Voice control (1,4.0%)	Smartphones can be controlled by speaking, such as making phone calls, navigating, etc. For older people with bad eyesight, there is no need to press the button (P17)
Positive emotional reactions (3,12.0%)	Indispensable (3,12.0%)	It's all good; I can't leave my smartphone right now (P10)

In response to the question about bad experiences and disadvantages of using digital technologies, three themes emerged from the thematic analysis: "General negative characteristics," "Provide access to specific services," "Device attributes," and "Negative emotional reactions" (Table 4.5). Compared to the positive attitudes, participants did not mention the theme of "Provide access to specific services" or an opposite equivalent (which might have been "Lack of access to needed services") when they discussed their negative attitudes toward digital technologies. For "General characteristics" theme, eight sub-themes emerged. Most notable among the sub-themes was "Eyesight problems", which were mentioned by over half of participants. In addition, an interesting sub-theme ("Danger of multitasking") part of the theme of "General characteristics" is that participants are worried about the dangers of using devices when walking or driving. Another interesting sub-theme is "False information": participants do not know how to tell the truth from fake information because there is too much false information that individuals on the Internet publish. In terms of the theme of "Device attributes," eight subthemes emerged. One interesting sub-theme was "Radiation," participants worried that digital devices would give off harmful radiation. Regarding the theme of “Negative emotional reactions”, compared to only one subtheme related to “Positive emotional reactions”, four subthemes of negative emotional reactions occurred. One sub-theme was “Privacy and security concerns” as participants have worries about things such as information leaks, telecom fraud, and their money being stolen online. Another sub-theme was “Fears of mis-operation”: they worried that they might click on the wrong link or enter the wrong amount when making a payment. An interesting sub-theme is “Technology dependence/addiction”, participants fear becoming addicted to digital devices or becoming too reliant on them. Finally, only two (8.0%) participants mentioned feeling “Frustration”, with digital technologies, which created the sub-theme with this name.

Table 4.5: Results of thematic analysis of older Chinese participants’ negative attitudes towards digital technologies and their concerns

Theme	Subtheme	Example quotes
General negative characteristics (18, 72.0%)	Eyesight problems (15, 60.0%)	Watching TV for a long time hurts the eyes (P3)
	Lack of exercise (3,12.0%)	Sitting and watching TV all the time can lead to lack of exercise. (P2)
	Need to move furniture (2, 8.0%)	There are requirements for home space, and the chairs must be moved to the table when I use it. (P24)
	False information (2, 8.0%)	Some information is not accurate; much false information online. (P6)
	New functionality difficult (1,4.0%)	We don't know how to use some new functions, and then we need to learn before using such as

		screen casting. (P19)
	Lack of important functionality (1,4.0%)	It can't clean the corners, and the chair should be set up before use. (P25)
	Losing (1,4.0%)	And sometimes I worried about the phone falling off, because it's slippery. (P14)
	Danger of multitasking (1,4.0%)	It is dangerous to use smartphones when walking or crossing the road. Using smartphones while driving is also very dangerous. (P7)
Negative Device attributes (13, 52.0%)	Device heavy/not portable (4, 16.0%)	The laptop is a little bit heavy (P11)
	Screen too small (4, 16.0%)	Smartphones' screen is too small to see clearly, and it is easy to press the wrong button (P24)
	Font too small/fixed (3,12.0%)	Because of presbyopia, I can't see clearly when the font is small. And some apps cannot enlarge the font (P11)
	Radiation (3,12.0%)	Smartphone has radiation. (P16)
	Device malfunctioning (2, 8.0%)	I am worried that the remote control will doesn't work after using it for a long time. It didn't turn it on when I wanted to turn it on, and I couldn't turn it off when I wanted to turn it off,

		especially when I was traveling. (P3)
	Wifi problems (2, 8.0%)	Using a computer have to be under a Wi-Fi environment and cannot take it out; if there is no Internet, it cannot be used (P19)
	Difficult to link devices (1,4.0%)	I cannot read it directly. It is inconvenient to import it from the computer to the Kindle with a data cable. (P19)
	Noisy (1,4.0%)	Vacuum robots' noise is a little bit loud (P17)
Negative Emotional reactions (16, 64.0%)	Privacy and security concerns (12, 48%)	I am worried about the leakage of personal information and some economic problems (P9)
	Technology dependence/addiction (6, 24.0%)	I put too much energy on the smartphone, reducing the time of reading (P2)
	Fears of mis-operation (4, 16.0%)	I buy something pay by WeChat payment, so I'm worrying about entering the wrong amount (P5)
	Frustration (2, 8.0%)	We don't know how to use some new functions, and then we need to learn before using such as screen casting. (P19)

Overall, participants used a variety of digital technologies in their daily lives before the COVID-19 pandemic and used them for various purposes. It is worth mentioning that many participants mentioned the use of vacuum robots. In addition, participants hold both positive and negative attitudes to digital technology products, overall not particular positive or negative, and they have many concerns about using them.

4.3.2 Topic 2: Digital technology and older Chinese people - during the COVID-19 pandemic

In terms of the overall effect of the COVID-19 pandemic on older Chinese people's lives, some useful background information that would related to the study. Just of half of the participants (13, 52.0%) thought their life was different during the COVID-19 pandemic, however a chi-square did not show that this was a significant proportion of the participants ($X^2(1) = 0.04$, $p = 0.84$). 19 (76.0%) participants reported that they did not feel lonely during the pandemic, while 6 participants (24.0%) did feel lonely, and 3 of them felt a bit lonely. A chi-square show that this was a significant proportion of the participants ($X^2(1) = 6.76$, $p = 0.009$). In addition, the majority of participants (20, 80.0%) indicated that they did not feel bored during the pandemic when they had to stay at home, while 5 participants (20.0%) felt bored and 3 of them only felt bored occasionally. A chi-square show that this was a significant proportion of the participants ($X^2(1) = 9.00$, $p = 0.003$).

RQ2a investigated digital technologies used by older Chinese people in their daily lives during the COVID-19 pandemic and what their purposes were. Content analysis was used to analyse which digital technologies the participants used during the coronavirus pandemic and explore their purposes.

In relation to the technologies used during the COVID-19 pandemic (Table 4.6), all participants mentioned using smartphones, followed in frequency by computers (13, 52.0%) participants; 8 (32.0%) participants said they watched television, and 2 (8.0%) participants used a tablet computer such as an iPad. One new device that only emerged in the analysis of during the **COVID-19** pandemic is the treadmill (1, 4.0%). In comparison to the types of digital technologies used before the COVID-19 pandemic, there are fewer types was mentioned by participants (Table 4.7). Compared to nine technologies mentioned by participants pre-COVID-19 pandemic, only five technologies were mentioned by participants during the COVID-

19 pandemic, which is less than the pre-COVID-19 pandemic. Although the number of technologies used during the pandemic is less than in the pre-COVID-19 pandemic, the differences are very small, with smartphones, computers, and televisions still the main technologies participants used.

Table 4.6 also shows the purposes digital technologies were used for during the pandemic. As with the situation before the pandemic, the purpose of “Contacting others”, “Shopping and payments”, “Information access”, “Entertainment”, “Working”, and “Booking” were mentioned by participants during the COVID-19 pandemic. Besides, some new purposes emerged, such as “Online studying”, “Health codes”[19], and “Exercise”. Participants mentioned that many offline courses had moved online (many participants are studying at senior colleges after retirement) because of the pandemic. In addition, “Health codes” have also become an essential part of their lives because they must show their health codes if they want to enter public places. In addition, participants could not go out, so they exercised at home during the lockdown periods. Table 4.7 shows the comparison of the purpose that participants used technologies between the pre-COVID-19 pandemic and during the pandemic. Compared to the 11 purposes participants mentioned pre-COVID-19 pandemic, only nine purposes were mentioned during the COVID-19 pandemic. Although the number of purposes for using technologies during the pandemic is less than in the pre-COVID-19 pandemic, the differences are very small; the purposes of “Contacting others”, “Shopping and payment”, “Information access”, and “Entertainment” still as the main purposes of participants using technologies during the COVID-19 pandemic.

Table 4.6: Use and purposes of digital technologies by Older Chinese participants’ during the COVID-19 pandemic

Purpose	**Digital technology**				
	Smartphones	**Computers**	**Televisions**	**Tablet computer**	**Treadmill**
	(25, 100.0%)	**(13, 52%)**	**(7, 28.0%)**	**(2, 8.0%)**	**(1, 4.0%)**

[19] Health codes: A type of a mobile application used in China during the COVID-19 pandemic. It serves as a digital passport that logs whether the user has recently been in an area where infections are prevalent. Users input details like their travel history, place of residence, and medical records. Subsequently, the application generates a QR code indicating the individual's risk level, which can be classified as red, yellow, or green

Contacting others (25, 100.0%)	**25**	**--**	**--**	**--**	**--**
Shopping and payments (18, 72.0%)	18	--	--	--	--
Information access (13, 52%)	9	3	3	1	--
Entertainment (13, 52%)	8	3	2	1	--
Online studying （5， 20.0%）	5	--	--	--	--
Health code （3，12.0%）	3	--	--	--	--
Exercise (2, 8.0%)	1	--	--	--	1
Working （1, 4.0%）	1	1	--	--	--
Booking （1, 4.0%）	1	--	--	--	--

Table 4.7: Participants' use of different digital technologies, before and during the pandemic

	Before the pandemic	*During the pandemic*
All purposes	Smartphone: 25 (100.0%) Computer: 13 (52.0%) Television: 7 (28.0%) Robot vacuum: 4 (16.0%) Tablet computer: 1 (4.0%)	Smartphone: 25 (100.0%) Computer: 13 (52.0%) Television: 8 (32.0%) Tablet computer: 2 (8.0%) Treadmill: 1 (4.0%)
Contacting others	Total N: 25 (100.0%) Smartphone: 25 (100.0%) Computer: 1 (4.0%)	Total N: 25 (100.0%) Smartphone: 25 (100.0%)
Information access	Total N: 22 (88.0%) Smartphone: 19 (76.0%) Computer: 9 (36.0%) Television: 5 (20.0%)	Total N: 13 (52.0%) Smartphone: 9 (36.0%) Computer: 3 (12.0%) Television: 3 (12.0%) Tablet computer: 1 (4.0%)
Shopping and payments	Total N: 18 (72.0%) Smartphone: 17 (68.0%) Computer: 1 (4.0%)	Total N: 18 (72.0%) Smartphone: 18 (72.0%)
Entertainment	Total N: 11 (44.0%) Smartphone: 7 (28.0%) Computer: 4 (16.0%) Television: 3 (12.0%)	Total N: 13 (52.0%) Smartphone: 8 (32.0%) Computer: 3 (12.0%) Television: 2 (8.0%) Tablet computer: 1 (4.0%)
Technology-mediated tasks	Total N: 5 (20.0%) Smartphone: - Computer: 5 (20.0%)	
Cleaning	Total N: 8 (32.0%)	

	Vacuum robot: 8 (32.0%)	
Hard-disk	Total N: 4 (16.0%) Smartphone: 1 (4.0%) Computer: 3 (12.0%)	
Working	Total N: 3 (12.0%) Smartphone: 1 (4.0%) Computer: 3 (12.0%)	Total N: 1 (4.0%) Smartphone: 1 (4.0%) Computer: 1 (4.0%)
Taking photos	Total N: 3 (12.0%) Smartphone: 3 (12.0%)	
Booking	Total N: 2 (8.0%) Smartphone: 2 (8.0%)	Total N: 1(4.0%) Smartphone: 2 1(4.0%)
Voice control	Total N: 1 (4.0%) Voice controller: 1 (4.0%)	
Online studying		Total N: 5 (20.0%) Smartphone: 5 (20.0%)
Health code		Total N: 3 (12.0%) Smartphone: 3 (12.0%)
Exercise		Total N: 2 (8.0%) Smartphone: 1 (4.0%) Treadmill: 1 (4.0%)

RQ2b investigated the attitudes of older Chinese people about using digital technologies during the COVID-19 pandemic and whether they changed from before the COVID-19 pandemic. Similar to investigating the attitudes of older Chinese people towards technologies before the COVID-19 pandemic, two questions (positive and negative attitudes related questions) were asked separately to investigate the attitudes of older Chinese people toward technology during the COVID-19 pandemic. Two separate thematic analyses were conducted on the answers to these two questions, but the results were also compared. These positive and negative themes will be discussed separately in detail below.

Overview, although participants discussed both positive and negative attitudes toward digital technologies when commenting on the experience of using digital technologies during the pandemic, participants expressed more positive attitudes than negative attitudes about digital technologies. Five (20.0%) participants expressed only positive attitudes and mentioned that digital technologies bring a lot of convenience, and they reported that they had no negative experiences of using digital technologies during the COVID-19 pandemic.

In response to the question about good experiences of using technologies, and what advantages of using technologies were during the COVID-19 pandemic. Table 4.8 shows the themes that related to participants' positive attitudes during the pandemic. In terms of the theme of “General characteristics”, only three sub-themes emerged. The most frequently occurring theme was "Convenient": participants thought technology brought them convenience, especially during the lockdown periods. Regarding the theme of “Provide access to specific services,” three sub-themes emerged. One thing worth noting is that all participants made comments related to the sub-theme of “Contacting others”: participants mentioned that they relied entirely on technology to stay social and in contact with others during the lockdown. Although participants expressed more positive attitudes toward using digital technology products during the COVID-19 pandemic, compared to the four themes mentioned by participants in the pre-COVID-19 pandemic, two themes were mentioned by participants during the COVID-19 pandemic. The themes were far fewer than pre-pandemic and focused on the theme of “General characteristics” and “Provide access to specific services” (Table 4.8).

Table 4.8: Older Chinese participants’ positive attitude towards digital technologies during the COVID-19 pandemic

Themes	Sub-themes	Example quotes
General positive characteristics (7,28.0%)	Convenient (19,76.0%)	Convenient, although I can't go out, I can understand the world,

		especially the pandemic situation in the city where I live. (P4)
	Provide specific functions (1,4.0%)	Smartphones replace many things, such as cameras, etc. (P14)
	Available all the time (1,4.0%)	I can understand the coronavirus pandemic situation anytime at home via smartphone. (P16)
Provide access to specific services (25, 100.0%)	Contacting others (25, 100.0%)	Relatives and friends greet each other through WeChat, and there are many WeChat groups; we can share pandemic information, such as some precautions, how to wear a mask, etc (P19)
	Information access (8, 32.0%)	Although I can't go out, I can understand the world, especially the pandemic situation in the city where I live (P4)
	Entertainment (2, 8.0%)	I played games. I think playing games can exercise the brain and fingers. (P21)

In response to the question about bad experiences of using technologies, and what disadvantages of using technologies were during the COVID-19 pandemic, three themes was mentioned by participants (Table 4.9). although participants mentioned three of the same themes as pre-pandemic, there are far fewer sub-themes was mentioned by participants (Table 4.10). In terms of the theme of “General characteristics,” only three sub-themes emerged, “Eyesight problems”, “Lack of exercise”, and “False information”. Regarding the theme of "Device attributes," compared to the eight sub-themes before the COVID-19 pandemic, only two sub-themes emerged during the COVID-19 pandemic, which are "Screen too small" and "Radiation." In terms of the theme of "Negative emotional reactions," compared there four sub-themes in the data before the pandemic, there is also only one sub-theme during the COVID-19 pandemic, which is "Technology dependence/addiction".

Table 4.9: Older Chinese participants' negative attitude towards digital technologies and their concerns during the COVID-19 pandemic

Themes	Sub-themes	Example quotes
General negative characteristics (13, 52.0%)	Eyesight problems (8, 32.0%)	Using smartphones for a long time hurts the eyes. We are getting older, and I feel my eyesight is affected if I use smartphones for a long time. I'm trying to reduce the time that I spend on the smartphone (P4)
	False information (3, 12.0%)	There is a lot of false news and information on the Internet during the pandemic (P23)
	Lack of exercise (2, 8.0%)	Lack of exercise due to sitting and watching the news is not good for our health. (P5)
Device attributes (2, 8.0%)	Screen too small (1,4.0%)	I played mahjong on the computer, the phone screen was too small (P17)
	Radiation (1,4.0%)	Smartphones have radiation (P10)
Negative emotional reactions (2, 8.0%)	Technology dependence/addiction (2, 8.0%)	The computer made my waist uncomfortable because it was so attractive, and time passed before I knew it (P22)

Table 4.10: Changes in participants' use of digital technologies during the COVID-19 pandemic

Positive			Negative and concerns		
Themes	**Before the pandemic(N)**	**During the pandemic(N)**	**Themes**	**Before the pandemic(N)**	**During the pandemic(N)**
General characteristics			**General characteristics**		
Convenient	19	6	Need to move furniture	2	--
Provide specific functions	9	1	New functionality difficult	1	--
Multifunctional	3	--	Lack of important functionality	1	--
Available all the time	4	1	Losing	1	--
Helps with poor eyesight	2	--	Eyesight problems	15	8
			Lack of exercise	3	2
			Danger of multitasking	1	--
			False information	2	3
Provide access to specific services			**Provide access to specific services**		
Information access	9	8			
Contacting others	7	25			
Payments	7	--			
Online shopping	3	--			
TV	3	--			
Entertainment	1	2			
Device attributes			**Device attributes**		
Portable	3	--	Device heavy/not portable	4	--
Screen size	3	--	Screen too small	4	1

Device size	1	--	Font too small/fixed	3	--
Flexibility of display	1	--	Radiation	3	1
Voice control	1	--	Device malfunctioning	2	--
			Wifi problems	2	--
			Difficult to link devices	1	--
			Noisy	1	--
Emotional reactions			**Emotional reactions**		
Indispensable	3	--	Privacy and security concerns	12	--
			Technology dependence/addiction	6	2
			Fears of mis-operation	4	--
			Frustration	2	--

21 (84.0%) participants said that they used more digital technologies and relied more on these technologies during the pandemic than before, and the remaining 4 (16.0%) participants did not use digital technologies more. A chi-square test showed that a significant proportion of the participants used digital technologies more during the pandemic ($X^2(1)=11.56$, $p < 0.001$).

18 (72.0%) participants thought they relied more on these technologies during the COVID-19 pandemic whereas 7 (28.0%) did not think they relied on them more. Again, this was a significant proportion of participants who thought they relied on digital technologies more during the pandemic (X^2 (1) = 4.84, $p < 0.05$)

In summary, overall participants used digital technologies more often and relied on them more during the COVID-19 pandemic. In addition, the COVID-19 pandemic has also changed participants' attitudes toward technologies. Some participants indicated that during the pandemic, digital technologies have only positive attitudes and no negative attitudes. They thought that digital technologies had brought much convenience to them, especially in terms of “Contacting others” and “Information access”. In addition, the pandemic has also prompted them to learn new technology skills, such as to be able to take classes online and to make mobile payments.

4.3.3 Topic 3: Issues about new technologies for older Chinese people Pre and during the COVID-19 pandemic.

RQ3a investigated older Chinese people's attitudes to new technologies. My aim was to investigate their attitudes both before and during the pandemic, but they always came back the COVID-19 pandemic when they talked about this topic. Thus, they were really talking about their attitudes since the COVID-19 pandemic. Participants rated their attitudes to new technologies that they have not used before (on at scale from “Not interested at all", rated as 1 to "Very interested", rated as 7). One participant did not give a specific answer. He stated that if the technologies are useful for him, he would be interested in them, not the other way around. Thus, I removed him from the data set for the analysis of this question. In the 24 responses, the median attitude to new technologies was 6.25 (SIQR = 1), ranging from 4 to 7. The overall response to this question was very positive; 7 participants answered with the maximum rating of "Very interested." A Wilcoxon Signed Rank test was used to compare the distribution of scores with the midpoint of the 7-Likert scale to investigate whether participants had positive or negative attitudes, the result shows participants hold significantly positive attitudes toward new technologies ($Z = -4.04$, $p < 0.001$).

Almost all participants (24, 96.0%) mentioned that they are going to use new technologies when they come out; only one participant say they would not, a highly significant difference ($X^2(1)=21.16$, $p < 0.001$).

Participants said that they could obtain information about new technologies in various ways. Content analysis was used to summarize the ways that participants obtained information about new technologies (Table 4.11). 21 (84.0%) participants said they obtained information from news and the internet, such as WeChat groups. 19 (76.0%) participants indicated that they get information about new technologies from other people, such as their friends and children. In addition, one participant said that he finds about new technologies through leaflets. Another participant mentioned that he likes going to high-tech expos to learn about new digital technologies.

Table 4.11: Ways older Chinese participants get information about new technologies

The way to get information	Example quotes
The news and the internet (21, 84.0%)	I mainly get information on WeChat, followed by TV and the Internet. (P15)
Other people (19, 76.0%)	I also got the information when I had a chat with friends. For example, if someone uses something I am interested in, then I search for information online, after which I may buy it. (P22)
Leaflets (1, 4.0%)	Someone is handing out leaflets on the street outside. (P16)
High-tech Expo (1, 4.0%)	I went to the High-tech Expo. (P17)

RQ3b investigated the factors that affect older Chinese people's decisions to use new digital technologies. Content analysis was used to explore these factors. The categories were derived from the Senior Technology Acceptance Model (STAM) (Chen & Chan., 2014), and the Almere Model (Heerink, et al., 2010). Table 4.12 shows there are four categories related to STAM and the Almere model: “Perceived usefulness”; “Facilitating conditions”; “Social influence”; and “Perceived ease of use”. But none of the other eight constructs (categories) in the Almere model (12 constructs totally) were mentioned by the participants, and there were also eight constructs (categories) in the STAM (11 constructs totally) model that were not mentioned by the participants. In addition, three themes were derived from the material: “User needs”; “Good quality and safety;” and “Older products need to be replaced or upgraded”. Table 4.11 shows the most frequent categories mentioned by among participants was “Perceived usefulness” (72.0%), followed by “User needs” (40.0%), and “Social influence” (32.0%).

Table 4.12: Categories affecting older Chinese participants' decisions to use new digital technologies

Categories	Theoretical models		Example quotes
	STAM	Almere Model	
Perceived usefulness (18, 72.0%)	√	√	It could bring convenience and improve quality of life. (P18)
User's needs (10, 40.0%)	--	--	It depends on whether this product is what I need. (P12)
Social influence (8, 32.0%)	--	√	Using too many technological products is unrealistic, as long as I can keep up with the pace of new technology. And I do not want to be out of step with society; I want to have a common topic with my children. (P7)
Facilitating conditions (6, 24.0%)	√	√	If economic conditions permit, I want to try a new product. (P10)
Good quality and safety (4, 16.0%)	--	--	Its price is not important, the safety and practicality are most important for me. (P9)
Older products have to be replaced or upgraded (3, 12.0%)	--	--	Digital technology products that must be replaced, such as smartphones. (P13)
Perceived ease of use (1, 4.0%)	√	√	I will buy it after I have learned how to use this technology product and become proficient. (P1)

RQ3c investigated the ways older Chinese people learn to use digital technologies. Content analysis was used to identify their methods for learning about these technologies. Table 4.13 shows three categories from the material. Most participants (22, 88.0%) mentioned that they learn to use digital technologies with "Other people's help", such as their children, friends, installation personnel, etc. Surprisingly, over half of the participants (13, 52.0%) said that they could learn to use digital technologies by themselves, such as by reading instructions and studying online material. In addition, an unexpected category was company training, 7 (28.0%) participants reported that they received "Company training" when they were learning how to use computers.

Table 4.13: Ways in which older Chinese participants learn to use digital technologies

Categories	Example quotes
Others help (22, 88.0%)	I was seeking help from young people when I encounter problems. Learn step by step, starting from the most basic functions. (P2)
Studied by themselves (13, 52.0%)	I studied to use smartphones is self-taught. I quickly learned how to use a smartphone when I switched from traditional phones to smartphones. For the laptop, I have used a desktop computer for more than ten years, so when I use a laptop computer, I get started quickly. (P11)
Company training (7, 28.0%)	I attended a computer training class, learned some basic knowledge. Then I bought computer books and studied by myself. (P11)

Participants also discussed their feelings about learning to use digital technologies. From the participants' descriptions, I summarized five levels of difficulty in learning to use digital technologies: "Very easy"," Easy", "Neither easy nor difficult", "Difficult", and "Very difficult". Table 4.14 shows participants' feelings about learning about different digital technologies. Surprisingly, the participants did not feel it was difficult to learn to use a smartphone. Computers seem to be more difficult to learn for participants than smartphones, which a larger percentage of participants felt learning to use a computer is difficult.

Table 4.14: Older Chinese participants technologies learning experience

Digital technology products	Very easy (N)	Easy (N)	Neither easy nor difficult (N)	Difficult (N)	Very difficult (N)
Smartphones N=19	--	7 (36.8%)	11 (57.9%)	--	1 (5.3%)
Computers N=11	1 (9.10%)	1 (9.10%)	5 (45.45%)	2 (18.18%)	2 (18.18%)

Television N=4	--	3 (75.0%)	1 (25.0%)	--	--
Vacuum Robots N=3	--	3 (100.0%)	--	--	--
Electronic keyboard N=1	--	--	--	1 (100.0%)	--
Voice control N=1	--	1(100.0%)	--	--	--
Plant light N=1	--	1(100.0%)	--	--	--

Taken together, these results show participants had positive attitudes toward new digital technologies that they had not used. In addition, I found that a variety of factors affect participants' decisions to use new digital technologies, such as perceived usefulness and user needs. In addition, many of the categories proposed by the Almere model. I also found that the participants did not find it very difficult to learn to use digital technology products; most of them learned to use digital technology products by themselves and with others' help.

4.3.4 Topic 4: Robots and older Chinese people

RQ4a investigated older Chinese people awareness of personal robots and their possibilities**.** Nearly all participants **(**23, 92.0%) knew that personal robots could help older people at home, while only two participants did not. A chi-square test showed that the number of participants with knowledge about personal robots was significantly more than those who did not ($X^2(1)=17.64$, $p < 0.001$). In addition, the knowledgeable participants knew that personal robots can help older people do domestic tasks, pick up objects, help disabled older adults, etc.

RQ4b investigated older Chinese people’s attitudes toward personal robots by exploring whether they are willing to use personal robots at home and their intention to use personal robots in the future. All participants discussed their opinions of willingness to use personal robots; 21 (84.0%) participants were willing to have personal robots help them in the home, while only four participants indicated that they did not want to use personal robots. A chi-square test showed that this was a significant difference of the proportion in the participants ($X^2(1)=11.56$, $p < 0.001$). In addition, all participants expressed their opinions about their intentions to use personal robots in the future. 22 (88.0%) participants indicated that they would use personal robots in the future, while only three participants reported that they do not think they would use personal robots because they will go to a nursing home or find professional care in the future. A chi-square test showed that this was a significant difference in the proportion of the participants ($X^2(1)=14.44$, $p < 0.001$).

In addition, 23 (92.0%) participants discussed their feelings about having personal robots in their home. 17 (73.9%) of these participants indicated that they would feel comfortable having a robot in their home, while only two participants (8.7%) feel uncomfortable. In addition, four participants (17.4%) considered that if personal robots can meet some conditions, they would feel comfortable, such as personal robots need to be obedient. A chi-square test showed that this was a significant difference in the proportion of participants ($X^2(1)=17.30$, $p < 0.001$).

RQ4c investigated which type of robot older Chinese people would prefer. Although they were offered the choice of social companion robots or task-oriented robots, many participants said they preferred both. Thus, three types of robots were analyzed: social companion robots, task-oriented robots, and robots with both characteristics. Overall, 23 (92.0%) participants expressed their opinions about their preferences for types of robots; 12 participants (52.2%) indicated that they would prefer robots that can have both social companion and task-oriented functions, 6 participants (26.1%) prefer task-oriented robots, 5 participants (21.7%) prefer social companion robots. Although over half of the participants preferred the robots that could cover both functions, a chi-square test showed that there was no significant difference in the proportion of participants ($X^2(2) = 3.74$, $p = 0.15$) preferring either of the three types.

The current needs of older Chinese people might be different from their future needs, 21 participants discussed their current needs for robot types; 11 participants (52.4%) reported that they prefer robots can have both social companion and task-oriented functions, seven participants (33.33%) preferred task-oriented robots, while three participants (14.29%) preferred social companion robots. For example, one participant (P18) said: "I like task-oriented robots, I have not considered social functions yet." A chi-square test showed there no significant difference in the proportion of the participants ($X^2(2) = 4.57$, $p = 0.10$) preferring each type.

In terms of the participants' future needs for a robot type, 18 participants gave their opinions. Fourteen of these participants (77.8%) indicated that they would prefer the robot to have both social companion and task-oriented functions; three participants (16.67%) indicated that they would prefer task-oriented robots, while only one participant (5.56%) preferred social companion robots. One participant (P10) stated:

> In the future, I will not only need robots to be able to communicate but also need robots to do some tasks. It can provide some services when older adults' life is inconvenient. Many older people are inconvenienced when they are old. Eyes and ears, including the go to the toilet, are not convenient. If there are robots that help go to the toilet, it is best.

Another participant (P19) commented:

> I have a smartphone, so I can communicate with my friends and relatives on smartphones. Besides, I prefer to communicate with people. I still need robots to help me do some clean tasks or measure my blood pressure and massage tasks.

The difference between participants' future needs in relation to the three robot types was significant (X^2 (2) = 16.33, $p < 0.001$), The null hypothesis was rejected; the number of participants who prefer companion robots, task-oriented robots, and the robot cover both characteristics does not equal, with a greater number of participants preferring robots with both types of function.

RQ4d explored older Chinese people's expectations of personal robots. Thematic analysis was used to analyze participants' expectations of personal robots. Sixteen themes have emerged, (Table 4.15.) The theme mentioned most by participants was "Doing domestic tasks" (48.0%). Participants hoped personal robots would help with housework, such as cleaning the home, cooking, and grocery shopping. The theme of "Communication" also recurred throughout the dataset (40.0%). Participants would like personal robots to chat with them and tell them jokes to entertain them. Another theme that participants brought up many times was “Affordable” (40.0%), participants hope that the cost of personal robots will be reasonable and affordable when personal robots become widespread. In addition, there are also other themes mentioned by participants several times, such as the themes of "Technical specification and good quality” (20.0%), “Information access” (12.0%), “Taking care of older people” (12.0%), and “Small size” (12.0%).

Table 4.15: Older Chinese participants’ expectations of personal robots

Categories	Definition	Example quotes
Doing domestic tasks (12, 48.0%)	Robots should be able to do household chores, such as sweeping the floor.	I hope robots can help me sweep the floor. (P4)
Communication (10, 40.0%)	To be able to communicate with robots through voice	“I hope robots chat with me, tell jokes, and be happy. As we age, there is less communication between young and old people. (P20)
Affordable (10, 40.0%)	The price of robots would be reasonable and affordable	I'd probably use it If I could afford it. If it's too expensive, I won't use it. (P18)
Technical specification and good quality (5, 20.0%)	The quality of the robot is good, and there is a technical guarantee.	After popularization and technical maturity, everything should be fine. (P12)
Information access (3, 12.0%)	Answering questions from users and helping them access information.	If I chat with this robot, I can learn a lot of new knowledge and have a good chat. If there is such a robot, I want it. I want robots can help me solve problems and increase my knowledge. (P22)
Taking care of older people (3, 12.0%)	Robots could take care of older people like professional caregivers.	At that time (future), I could no longer move, then rely on robots for feeding, sanitation, and bathing. (P2)
Small size	The robot is small and does not take up too	If it's a small robot like that, I'd love

(3, 12.0%)	much space.	to have one of them. (P21)
Easy to use (2, 8.0%)	The degree of using robots would be free of effort	I hope that the robot is very simple, not too complicated. (P18)
Companionship (2, 8.0%)	Robots could fulfill the emotional needs of older people by providing companionship.	I am afraid of being alone. (P21)
Reminding (1, 4.0%)	Remind the user of their schedule, physical condition, and home security, etc.	A few years later, I'm old and can't remember things, it's good to have a robot to remind me. (P12)
Monitoring home safety (1, 4.0%)	Monitor home security, such as gas leaks and break ins.	I hope the robot can monitor the safety of the home. For example, it can remind me when the gas is off. (P2)
Health monitoring (e.g. measuring blood pressure) (1, 4.0%)	Monitor the user's physical condition, such as blood pressure, etc.	I need a robot to measure my blood pressure. (P19)
Fall detection (1, 4.0%)	Robots can detect that the user has fallen at home; check the location after their falls, and then find them.	I hope that the development direction of robots is to take care of physical safety. For example, if I fall, the robot can call for me or call for help. (P20)
Fetch objects (1, 4.0%)	Fetch objects for the user.	I hope robots could help me pick up objects. (P20)
Interaction method (voice) (1, 4.0%)	Users can interact with robots or give commands by voice.	Many technology products can be used through voice control now. For example, in household appliances, I use a TV, and I can let it switch the channel through voice commands. (P10)
Cognitive abilities (1, 4.0%)	Robots have cognitive abilities.	I hope that robots have thoughts and cognitive abilities. (P9)

RQ4e explored older Chinese people's concerns about having and using personal robots in their daily lives. Surprisingly, only over half of the participants (13, 52.0%) reported concerns, while the remaining 12 (48.0%) said they did not have any concerns. Six themes have emerged from the thematic analysis, (see Table 4.16). The themes of “Privacy and security concerns”, and “Malfunction” recurred throughout the dataset. Participants worried that personal robots would leak their personal information, and that personal robots would not obey their orders. Participants were also concerned that they would not be able to operate a robot or not be able to use it well. In addition, participants also did not want a robot to look like a real person, which would scare them (the Humanoid theme). It is worth mentioning that the participants also mentioned that they do not want the robot to affect their daily routine, participants do not want the robots to come to talk to them when they are sleeping or working. Finally, one participant also mentioned that he worries that the robot will trick him.

Table 4.16: Themes on Older Chinese participants’ concerns about having and using personal robots (N = 13)

Categories	Definition	Example quotes
Privacy and security concerns (5, 38.46%)	Robots leak personal information, such as phone numbers, home addresses, and bank details.	The privacy security issues, I'm worried about the camera. (P17)
Malfunction (5, 38.46%)	Robots are malfunctioning and cannot be used.	I am worried that the robot is malfunctioning and will not obey my orders. (P1)
Operation (4, 30.77%)	Participants worried that they would not know how to operate the robot.	I am worried that I will not be able to operate robots, especially when my children are not around. (P6)
Humanoid (3, 23.08%)	Robots are too much like real humans.	If robots look like a real human, I will feel scared. (P3)
Affect daily routine (3, 23.08%)	The existence of the robot disturbs the daily routine of the user. e.g. sleeping time	It's just that robots can't interfere with my life. (P22)
Deception	Robots deceive users.	Because I don't understand how robots were produced, such as programming. So, I worried

(1, 7.69%)	about privacy and deception. I saw a movie about robots during the pandemic, and the robots came to attack humans. (P2)

Overall the participants have a certain understanding of how personal robots can help older people, have a positive attitude toward personal robots, and are willing to use personal robots in their daily lives. Participants also have many expectations about personal robots and hope personal robots can assist them in all aspects of life as well as being a companion for them. At the same time, they also have some concerns about using personal robots.

4.4 Discussion

This study investigated older Chinese people's digital technology use and attitudes in the context of their daily lives and the COVID-19 pandemic, and their attitudes toward digital technologies and personal robots. RQ1a, which investigated the digital technologies used in older Chinese people's daily lives (pre-COVID-19 pandemic), found that older Chinese people used a comprehensive range of digital technologies, ranging from daily necessity technologies, such as smartphones, to more optional technologies, such as vacuum robots. The results support evidence from previous studies in other countries that have shown that older people use a variety of technologies in daily life (Fausset et al., 2013; Mitzner et al., 2010 Quan-Haase et al., 2018). However, the study found that a more advanced variety of technologies were used in older Chinese people's daily life, such as plant lights and vacuum robots, not just traditional household appliances and necessity technologies, such as televisions, smartphones, computers, and tablets, which is different from previous studies (Fausset et al.., 2013; Quan-Haase et al., 2018; Vaportzis et al., 2017; Wang et al., 2019).

RQ1b, which investigated the purposes for which older Chinese people use digital technologies (pre-COVID-19 pandemic), found that all participants mentioned that they communicated with others through WeChat rather than traditional ways of communicating such as landline phone calls. This finding is consistent with that of Quan-Haase et al. (2018) who found that the most frequently cited purpose of using technology by older Canadians is keeping in touch with family and friends. But the difference between older Chinese people and older Canadians is they are using different communication software. Older Canadians use various messaging apps, such as email, Facebook, and Twitter, while older Chinese people only use WeChat. While preliminary, this finding suggests that WeChat has replaced traditional communication methods as the primary communication method in participants' daily lives. In addition, WeChat is not just a communication tool, WeChat's shopping and mobile payment functions also play an important role in older Chinese people's daily lives. They buy daily necessities, make hospital appointments via WeChat, and make mobile payments via WeChat when they shop and eat outside. In addition, WeChat is an important way for older Chinese people to obtain information; and they share information and news via WeChat.

Another important finding was the theme of “Browsing news” and “Information access”. This finding was also reported by Quan-Haase et al. (2018). Participants prefer browsing news and Information access online because the news from the internet is faster than traditional channels, such as newspapers. In addition, they are accustomed to online inquiries when they encounter problems they do not understand in their daily life. From this, one can see that browsing news and obtaining information is one of the important purposes for participants to use digital technologies. The way older Chinese people obtain information is changing with the development of technology, and they prefer to get information and news through smartphones and computers via the Internet rather than via traditional channels. In addition, one unanticipated finding was that over one-third of the participants used a robot vacuum to clean their homes. This finding is consistent with that of Frennert and Östlund (2015), who found that older Swedish people are enthusiastic about adopting the robotic vacuum. An implication of the robot vacuum being widely used in older Chinese people’s daily lives is that possibly older Chinese people have begun to use artificial intelligence products to help them do some simple housework.

RQ1c, which investigated older Chinese people’s attitudes to using digital technologies in their daily lives (pre-COVID-19 pandemic), found that Chinese older people have both positive and negative attitudes towards technology, but overall neither particularly positive or negative. Their positive and negative attitudes focused on different aspects of digital technologies: positive attitudes were mostly focused on the “Provide access to specific service”, while their negative attitudes were mostly focused on the attributes of devices and their “Negative emotional reactions". These differences may be due to the fact that various apps now provide many different functions which make daily life much more convenient for older people. Apps now cover all aspects of our daily life and have changed older Chinese people's lifestyles, especially in the important aspects of "Information access" and " Contacting others", and have also brought convenience to their lives, which is also one of the main purposes for older Chinese people to use technologies.

However, as the physical capabilities of older people decline, the hardware limitations related to digital devices make it difficult for them to use technologies easily, for example, screens are too small and they cannot read the text on them. Therefore, developers should pay special attention to these hardware-related limitations when designing technology products for older people. Another interesting finding is that older Chinese people had concerns about technology dependence and addiction, a finding that does not seem to have been previously been described in the literature. This may be related to the phenomenon of Internet addiction among older Chinese people, especially after short videos became popular, and many older Chinese people now spend much time watching short videos or browsing the news, which has received by publicity in the news media[20, 21].

On the other hand, the positive attitudes of older Chinese people towards technology in relation to the "Provide access to specific services could also explain the changes in their technology use. Technology brings convenience to their lives, especially regarding "Contacting others" and "Information access". Therefore, understanding the attitudes of older Chinese people to technology is important, which could help them accept and use new technology products they have not previously used.

RQ2a, which investigated the digital technologies used by older Chinese people in their daily lives during the COVID-19 pandemic, and RQ2b investigated their purposes in using these technologies. Smartphones, computers, and television are still the technologies mentioned by participants as those they used during the pandemic, as before the pandemic. However, the COVID-19 pandemic has caused older Chinese people to use a slightly smaller variety of digital technologies than before. Similarly, the main aspect of Older Chinese people's use of digital technology products during the pandemic is still connecting with others and information

[20] URL: http://opinion.people.com.cn/n1/2021/0923/c1003-32233594.html
[21] URL: http://www.crca.cn/index.php/13-agednews/738-1-19.html

access, similar to pre-COVID-19 pandemic period. It is worth noting that the changes in online shopping and mobile payment have not changed as much as might be expected. This result may be explained by the fact that online shopping and mobile payment are already popular in China before the pandemic. According to data released by the Alibaba Group Holding Limited (a Chinese multinational technology company specializing in e-commerce, retail, Internet, and technology) in December 2019, the number of active mobile users per month in China's retail market reached 824 million[22]. Most of the participants in this study had started online shopping and mobile payment before the COVID-19 pandemic.

RQ2c investigated older Chinese people's attitudes to using digital technologies and whether they changed as a result of the COVID-19 pandemic. The study found that the COVID-19 pandemic had made older Chinese people's attitudes toward digital technology products more positive. They indicated they felt deeply the convenience brought by digital technology products during the COVID-19 pandemic and have become more dependent on technology products, especially for keeping in touch with others, knowing the current international and domestic COVID-19 situation and when they have to stay home because of the situation. Many older Chinese people even said that technology products had almost no negative effects during the pandemic. However, although older Chinese people expressed a more positive attitude toward technologies, they only focused on the theme of "Contacting others" and " Information access" when they discussed this topic, and no new themes emerged. A possible explanation for this might be older Chinese people used technology more frequently and for more time than usual, but the behaviour and purposes of technology use did not change. In addition, technology is the only way for older Chinese people to keep in touch with others and obtain information during the COVID-19 pandemic.

RQ3a investigated older Chinese people's current general attitudes to new technologies. The study found that older Chinese people hold positive attitudes toward to new technologies, and they willing to try new digital technology products in the future. The COVID-19 pandemic also played an important role in the positive attitudes of older Chinese people towards new technology products. As mentioned above, the COVID-19 pandemic has made them deeply appreciate the benefits of digital technologies; thus, they are willing to try new technological

[22] URL information from website: https://www.alibabagroup.com/document-1491861354372399104

products. Another possible explanation for this is that related the RQ3c of the experience of older Chinese people in learning to use digital technologies. The study found that it is not difficult for older Chinese people to learn to use digital technologies. Thus, learning to use new technology products is a relatively easy task for older Chinese people. Although they need to rely on the help of others to learn to use some relatively complex digital technology products, such as computers, they can learn many simple digital technology products by themselves, such as vacuum robots. Therefore, they are willing to use and learn to use new digital technology products in the future. This finding is consistent with that of Vaportzis et al. (2017) who found older British people are interested in learning how to use technology.

With respect to RQ3b of the factors affect older Chinese people's decisions to use new digital technologies, the study found that many factors will affect their decisions whether to use a new technological product they have never used before. The factor that participants most frequently mentioned is “Perceived usefulness,” which is in agreement with Frennert et al’s. (2012) findings that showed the usefulness will determine the acceptance of robots; although the Frennert et al. study was focused on robots, robots are obviously in the category of new technology. In addition, some of the influencing factors found in this study support the technology or robot acceptance models (Chen & Chan, 2014; Davis, 1985; Heerink, et al.,2010; Venkatesh et al., 2003), such as “Perceived usefulness”, “Facilitating conditions”, “Social influence”, and “Perceived ease of use”. But one unanticipated finding was that “Perceived ease of use” is often has often been regarded as an important influencing factor in the previous research, but it was only mentioned by a few participants in this study. In addition, an important influencing factor of “User’s needs” was highlighted by participants. Although those models have not described this factor, it agrees with a study conducted by Frennert and Östlund (2020), who found “Needs or purpose” as pre-conditions of older Sweden people to use robots. The study also found some new influencing factors have not previously been described, such as “Good quality and safety”, and “Older products have to be replaced or upgraded”.

These findings and differences are worthy for further research to determine whether these influencing factors are only applicable in the Chinese context or can be applied to different cultural contexts. Another point worth mentioning is that in the open-ended questions participants in this study did not use many of the Almere model constructs or STEM constructs.

The fact that they did not think of saying it spontaneously does not mean it is somewhat important to them, but it is interesting that they did not bring them up spontaneously.

On RQ4a which investigated whether older Chinese people are aware of personal robots and their possibilities, the study found that older Chinese people have an understanding that robots can be used to care for older people, because they often saw the news about how robots help older people in daily life. In addition, many participants indicated that they already use a robot vacuum and they had seen their children or friends use Xiaomi or Xiaodu (Chinese smart speakers, similar to Amazon Alexa) in their homes. Therefore, older Chinese people were familiar with the concept of robots helping people and that new technologies can be helpful to many people. This result could also provide an explanation of RQ4b of older Chinese people’s attitudes toward personal robots; the study found that older Chinese people hold positive attitudes toward robots, they are willing to use robots and thought they would use robots in the future, which is contrary to that of Zhang et al. (2019) who found older Chinese people rejected to use robots to take care of them. A possible explanation for this might be the older Chinese people who participated in my study were relatively younger than the participants in Zhang's study, thus, they hold positive attitudes toward using robots to care for them in the future. Further work is needed to identify whether the age affects older Chinese people's attitudes toward robots. In addition, the results show that older Chinese participants are willing to use robots and other new technologies in the future. The present study raises the possibility that older Chinese people hold similar positive attitudes toward robots and other new technologies. In addition, they have similar concerns about using robots and other technologies concerning “Privacy and security concerns” and “Operation” concerns. Therefore, this finding suggests that older Chinese people have similar attitude towards robots in comparison with other technologies. But further research should be conducted to investigate this further.

RQ4c investigated which type of personal robot older Chinese people would prefer. There was no significant difference in their preference for robot types in general, but over half the participants preferred robots with both companion and task-oriented functions. Because the participants were relatively “young old”, all were in their 60s, their current needs for robots are different from their needs in the future. Many reported that they do not need companionship or task-oriented help now, but they hope that robots can help them in all aspects when they are older. Further research is needed with cohorts of Chinese older people already in their 70s and 80s about their attitudes to personal robots to extend these results. On RQ4d and RQ 4e investigated older Chinese people's expectations and concerns of having personal robots. Older Chinese people's expectations are aligned with their preferences for the type of robot. They expected that robots could act as a companion, provide information and undertake tasks such as "Doing domestic tasks". Thus, they want personal robots can take care of them in all aspects. These results are in agreement with Bedaf et al's (2018) findings which showed older Dutch people want robots to perform more intricate tasks, which require the robot to be highly adaptable and intelligent, akin to human caregiving, comparable to the level of care provided by a human caregiver. Interestingly, the study found that participants did not have many concerns about personal robots, although there were concerns about "Privacy and security concerns", "Malfunction", and ability to "Operation" a robot. Although participants have positive attitudes towards robots and are willing to use them, many participants lack confidence in using them. Thus, developers need to make robots secure and easy to operate to build older people's confidence in personal robots.

The study has an interesting finding in that the themes of health and information seeking and receiving ran throughout the study, whether participants were discussing their experiences of using digital technology products or their expectations for new digital technologies and personal robots. It can be seen that these two aspects are important for older Chinese people. They hope that using technological products will not affect their health or will benefit their health. In addition, they attach great importance to acquiring information and learning new knowledge.

This study used qualitative methods to investigate older Chinese people's technology use and their attitudes toward them, as well as their attitudes toward the robot. Participants reported their attitudes spontaneously, which might lead to details being overlooked, for example, participants discussing factors that influenced their use of technology that have less relevance to existing technology acceptance models of older people's attitudes (STAM, the Almere model). In qualitative research, there are different kinds of validity. Wainer and Braun (2013) characterize one type of validity in quantitative research as "construct validity." The construct is the initial concept, notion, question or hypothesis that determines which data is to be gathered and how it is to be gathered. For the term of "validity" in qualitative research, Noble and Smith (2015) conclude that it is the “the precision in which the findings accurately reflect the data”. In addition, Flick (2022) discussed types of validity in qualitative research. Flick concludes that validity is defined as the extent to which researchers accurately perceive what they intend to observe. She also mentioned potential errors including misidentifying or misinterpreting relationships and asking incorrect questions. Flick also mentioned that assessing validity involves establishing a link between the studied relations and the researcher's interpretation, emphasizing the empirical grounding of these constructions, and communicative validation involves participants further in the research process to enhance authenticity and the structural development of statements. As this study was a mainly qualitative one, communicative validation was used. I summarized each participant’s opinions and verified them with the participant at the end of each topic during the interviews.

Regarding the reliability of this study, Noble and Smith (2015) define “reliability” in qualitative research as “the consistency of the analytical procedures, including accounting for personal and research method biases that may have influenced the findings”. In addition, Flick (2022) highlights that procedural reliability is gaining importance in qualitative research, particularly in ethnographic studies. Standardization of data collection methods, such as through structured field notes, transcription rules, and interview training, all enhance reliability. Training observers, maintaining transparency in interpretive procedures, and documenting the research process also contribute to overall reliability. The focus shifts from mere repetition of data collection to ensuring dependability of data and procedures, grounded in the specifics of qualitative methods. She emphasizes the need for detailed documentation of the research process and rejects the notion of reliability solely based on repeated data collection. Instead, she underscores the importance of thorough explication and transparency to enhance reliability in qualitative research methodologies. Thus, to ensure the reliability of this qualitative research, all data was voice recorded for repeated checking. The data analysis work was undertaken by two researchers. I did the initial data sorting and analysis work, then discussed it with my supervisor to finalize the results (Flick, 2022). Nevertheless, further quantitative research should be used to continue to explore the attitudes of older Chinese people towards technology and robots. I only interviewed 25 people, and there over 400 million older people in China.

With respect to the generalisability of the results, a number of aspects need to be considered.

As already noted, the sample is an urban area of China. Thus, I am not trying to generalize to people living in rural areas of China. But is the participants were typical of urban older Chinese people. Nonetheless, it is unfortunate that the study did not include older people from rural areas in China. Another issue for the generalizability of this study is that participants were all under the age of 69. Thus, the findings are about the attitudes and experiences of younger old Chinese people. With a sample of 25 it is hard to tell how representative the sample is of all Older Chinese people in their 60s living in urban areas. I may have sampled people who are particularly positive about technology because they volunteered to be in my study and perhaps people who volunteer to be in research studies are better educated and more open new technologies. Further research with different samples is needed to validate the findings.

Further research might explore older Chinese people of a large range of ages, and who live in different areas. Furthermore, participants reported their opinions of personal robots based on their prior knowledge without any interaction with personal robots. Considerably more work will need to be done to determine their use and attitudes toward personal robots in more detail in the future.

4.5 Conclusions and future work

A thorough understanding of older Chinese people's use of and attitudes to technology is important for helping them accept and use technology products. The main goal of the current study was to explore older Chinese people's digital technologies use and attitudes toward new digital technologies and personal robots, and also investigate whether the pandemic impacted their use and attitudes toward digital technologies. This study found that older Chinese people use various digital technology products and achieve different purposes in their daily lives, they have both positive and negative attitudes of digital technology products that they use in their daily lives. The second major finding was that older Chinese people are interested in and hold positive attitudes toward new digital technologies. The COVID-19 pandemic promoted a more positive attitude toward technologies by older Chinese people. The third finding of the study is that older Chinese people hold positive attitudes about personal robots and intend to use them, particularly in the future. In addition, older Chinese people prefer to have robots that could cover both companion and task-oriented functions as they get older. Older Chinese people had many expectations about personal robots, which cover all aspects of using personal robots, such as functions, appearance, and interactive ways. On the other hand, although they are concerned about “Privacy and security”, “Malfunction”, and “Operation” issues, the majority older Chinese people are not concerned about using personal robots.

To the best of my knowledge, this project is the first investigation of older Chinese people's technology use and attitudes. The findings reported here shed new light on improving the experience of older Chinese people when using technology products. In addition, the contribution of this study has been to confirm that older Chinese people hold a positive attitude toward new digital technologies and personal robots. The study also elicited the preferences and expectations of a sample of older Chinese people for robot types, which will help developers to design robots that meet the needs of old Chinese people. The present study lays the groundwork for future research into older Chinese people's use and attitudes toward new digital technologies and personal robots.

With the increasingly serious problem of population aging, using digital technology products to help older people can reduce the pressure on society and family members and help children take better care of older people. However, how to help older people to better use and accept new technological products is the primary problem to be solved, such as easy operation, appropriate price, and enhance the confidence of the older people in using new technological products or personal robots, which can help older people to accept and use them.

Chapter 5: Study 3: Investigation of older Chinese people's attitudes and preferences for different robot types

5.1 Introduction

Study 2 found that older Chinese people hold both positive attitudes toward new technologies and robots and are willing to use them in the future, but overall their views were positive. However, the older Chinese participants in Study 2 were all in their 60s, so relatively young and they were living independently. They would currently prefer to use robots with a single type of function, such as companion robots or task-oriented robots. However, they think they would prefer to use robots that can cover both characteristics in the future when they may find it hard to live independently. Study 2 was a preliminary exploration of the preferences and needs of older Chinese people for different types of robots. Therefore, this study explored more deeply the attitudes, preferences, and expectations of older Chinese people toward different robot types. In study 2, I gave a brief verbal introduction to participants about the two robot types (companion robots and task-oriented robots), including information about the robots' appearance, purposes, and functions. But this study I showed videos of three types of robots to the participants to help the participants get more information to get the whole picture of the different types of robots.

As discussed in the literature review (see Chapter 2, section 2.8.3) numerous studies have investigated older people's attitudes towards robots, with studies suggesting that older people have different attitudes toward particular types of robots. For example, regarding task-oriented robots, some studies show that older people hold positive attitudes toward task-oriented robots (McColl & Nejat., 2013; Louie et al., 2014; Smarr et al., 2014; Bedaf et al., 2018; Park et al., 2019), while others show older people hold negative attitudes toward task-oriented robots and don't want robots to help them (Wu et al., 2016)

Although many studies have investigated older people's attitudes towards particular types of robots, as far as I am aware no previous study compared older people's attitudes towards different types of robots and investigated which type of robot they prefer and which type of robot might better meet their needs. Therefore, this study investigated older Chinese people's attitudes toward three different robot types to identify their preferences for the different robot types. Thus, the first objective of this study was to examine older Chinese people's attitudes, preferences, and expectations regarding different types of robots. The second purpose of this study was to compare older Chinese people's attitudes toward different robot types and which type of robot older Chinese people prefer.

The study investigated the following research questions:

RQ1: What are Older Chinese people’s attitudes toward the three robot types: companion pet robots, task-oriented table robots, task-oriented movement robots?

RQ2: What are Older Chinese people’s preferences for the three robot types: companion pet robots, task-oriented table robots, task-oriented movement robots?

RQ3: What are Older Chinese people’s expectations about personal robots in general, and the three robot types in particular: companion pet robots, task-oriented table robots, task-oriented movement robots?

RQ4: What are Older Chinese people’s concerns about using personal robots in general?

5.2 Method

5.2.1 Design

As mentioned in the literature review (see Chapter 2, section 2.7), robots designed for older people serve two essential functions: companionship and assistance. Thus, this study investigated older Chinese people’s attitudes toward companion pet robots and task-oriented robots. In addition, two types of task-oriented robots were mentioned by participants in Study 2, task-oriented table robots and task-oriented movement robots. Many participants mentioned that their friends or children were using task-oriented table robots (e.g., Xiaodu and Xiaomi, which are Chinese smart speakers, which are similar to Amazon Alexa), and many participants use vacuum cleaner robots (which are a type of task-oriented movement robot) in daily life. Therefore, this study investigated older Chinese people's attitudes and preferences for three different types of robots: companion pet robots, task-oriented table robots, and task-oriented movement robots.

The inclusion criteria for participants were the same as in previous studies in this research of programme: the participants needed to be over 60 years old and retired (see Chapter 3, section 3.2.1).

Semi-structured individual and group interviews were used in the study. Individual interviews are best in providing personalized and detailed information from individual participants. Interviews foster a deeper level of trust and confidentiality, allowing respondents to express their opinions freely (Flick, 2022). Moreover, interviews enabled me to delve into specific details and follow up on responses, uncovering deeper motivations and rationales behind participants' opinions. In terms to the group interviews, the diverse perspectives presented during a group interview can often lead to the discovery of unanticipated trends or ideas, making it an excellent exploratory tool (Flick, 2022). Additionally, the group setting encourages participants to build upon one another's ideas, generating richer and more in-depth discussions. Due to the circumstances of the COVID-19 pandemic, individual interviews were conducted both online and face-to-face, the group interviews were conducted face-to - face. Conducting group interviews were also used for practical reasons, because of the difficulty of interviewing enough people for face-to-face individual interviews in China in the limited time that I had.

A four section schedule was used in both the individual and group interviews. The first section was an introductory section, to get to know the participants and their general knowledge about robots. The second section explored participants' attitudes towards each robot type in turn. As one of the aims of the study is to explore and compare the attitudes of older Chinese people towards different types of robots. Therefore, there are three videos in total according to different types of robots. Participants watched a video about each robot type, which provided basic information and special characteristics about each robot type. After each video there were questions about attitudes to it. The third section asked about preferences for the robot types and expectations of the robots. At the beginning of this section, I will reiterate to the participants the characteristics of these three types of robots, and what is different between each robot type with others. I asked participants to rank the robots and robot types in order of preference. Although it would be better statistically to use Likert items, I did this study over WeChat (similar to Zoom). Doing interviews over WeChat it was much easier and more natural for the older participants to rank the robots rather than answer Likert items about each one. Because I could not be with them, I could not give them a piece of paper and show them how to do a rating item. My participants were not at all familiar with the idea of a rating item, and it would have been complicated to try and explain this over WeChat. In addition, I was concerned that participants may have given each robot a similar rating out of politeness if using the Likert items, whereas the ranking forced them to at least put the robots in a particular order, although even this did not always work, for example, some participants only chose their most preferred task-oriented robots, they did not give their ranking of the other two robots. The fourth section collected demographic information. To avoid practice or fatigue effects, participants the order of viewing the videos was counterbalanced. If everyone watched them in the same order there might be boredom or fatigue effects. Individual participants might well have got bored or tired, but by showing the videos in different orders, those effects even out across the videos. Table 5.1 shows the viewing order for the robot videos.

Table 5.1: The viewing order for the robot videos

Video viewing sequence	Robot video		
1	Companion pet robots	Task-oriented table robots	Task-oriented movement robots
2	Task-oriented table robots	Task-oriented movement robots	Companion pet robots
3	Task-oriented movement robots	Companion pet robots	Task-oriented table robots

5.2.2 Participants

Snowball and opportunistic sampling methods were used in participant recruitment. For the recruitment of participants for the individual interviews, I first approached participants whom I knew who met the inclusion criteria (i.e. opportunistic sampling). Then through these participants, I asked them if they know anyone else who met the criteria and would like to participate (i.e. snowball sampling).

For the recruitment of participants for the group interviews, I contacted a community activity centre for older people in Hefei (a city of 9.37 million people which is the capital of Anhui province, located in the centre of China), and briefly introduced the study and asked if they would recruit participants for me.

53 participants took part in the study, their average age was 68.7 (SD:7.4) years, ranging from 60 to 93 years old. 16 (30.2%) were men and 37 (69.8%) were women. All participants were retired and lived in an urban area.

27 participated in an individual interview, 21 online through WeChat and 6 in person. 26 participants took part in group interviews, divided into four groups (Table 5.3). Table 5.2 shows the age and gender breakdown for the different data collection types.

Table 5.2: Age distribution of participants in Study 3

	Individual interview N = 27			**Group interview** N = 26	**Total** N = 53
	Total N = 27	Face to face N = 6	Online N = 21		
Age					
60-69	21 (77.8%)	1 (16.67%)	20 (95.24%)	10 (38.5%)	31 (58.49%)
70-79	2 (7.41%)	2 (33.33%)	-	14 (53.85%)	16 (30.19%)
≥80	4 (14.81%)	3 (50.0%)	1 (4.76%)	2 (7.69%)	6 (11.32%)
Gender					
Male	12 (44.44%)	11(16.67%)	11 (52.38%)	4 (15.38%)	16 (30.19%)
Female	15 (55.56%)	5 (83.33%)	10 (47.62%)	22 (84.62%)	37 (69.81%)

Table 5.3 Age and gender distribution of participants in group interviews

	Age groups		
	60-69	**70-79**	**80 above**
Group interviews 1 (N=7)			
Male	-	1	-
Female	-	6	-
Group interviews 2 (N=5)			
Male	-	-	-
Female	5	-	-
Group interviews 3 (N=5)			
Male	1	-	-
Female	4	-	-
Group interviews 3 (N=9)			
Male	-	2	-
Female	-	5	2

5.2.3 Materials and equipment

5.2.3.1 Example robots and videos

Three robots were chosen to illustrate each robot type. I searched YouTube and relevant websites for short videos illustrating the features of each robot. I created videos for companion pet robot type approximately 1.5 minutes, with about 30 seconds illustrating each robot in that type. Regarding the task-oriented table and movement robot types, the video approximately 2.25 minutes, with about 45 seconds illustrating each robot. These two robot types have many functions that could assist older people in their daily lives; thus, those videos take more time to show those functions. In addition, I created Chinese subtitles for each video.

For the companion pet robot type I chose the robots Paro, MiRo, and Aibo. These three companion pet robots were chosen because they are representative of a range of pet robots, with differing features. Paro is immobile and looks like a stuffed toy. MiRo has more pet characteristics and also has a circadian rhythm of being awake and sleeping, like a real animal. Aibo has more practical functions, such as taking pictures.

Paro (Figure 5.1A) is one of the best-known commercial companion pet robots, shaped like a baby seal. It can move and make seal noises in response to touch, light, noise, and orientation (Wada & Shibata, 2007).

MiRo (Figure 5.1B) is a small mobile companion pet robot that resembles a cross between several small mammals, such as a rabbit or dog, while being clearly robotic (Mitchinson & Prescott, 2016). MiRo is approximately 40 cm tall, with six sensors and eight degrees of freedom and a "biomimetic" control system (meaning it is a machine that mimics biological features). It can interact with people and appears to express emotions such as happiness and annoyance. It can move autonomously: its head, eyes and ears all move to create expressions and it reacts in a pet like way to human interaction, for example it can nudge a human in response to being petted and turns towards a human voice (Collins et al., 2015; Prescott et al., 2017).

Aibo (Figure 5.1C) is a robotic dog from Sony. It looks like a dog, and can react to emotions and obey the user's voice and commands (Fujita, 2004). One of the notable features of AIBO is its ability to learn and adapt to its owner's preferences and lifestyle. Through continuous interaction and reinforcement learning, AIBO develops a unique personality and character traits that are shaped by the way it is treated and engaged with by its human companions.

Videos were chosen from YouTube to show the different features that companion robots could achieve and how older people could interact with them. For the MiRo robot I selected two YouTube videos and edited them together into one 30s video. for the other robots, I used one video. Table 5.4 summarizes the videos for the companion pet robots.

A B C

Figure 5.1： Companion pet robots (A: Paro, B: MiRo, C: Aibo)

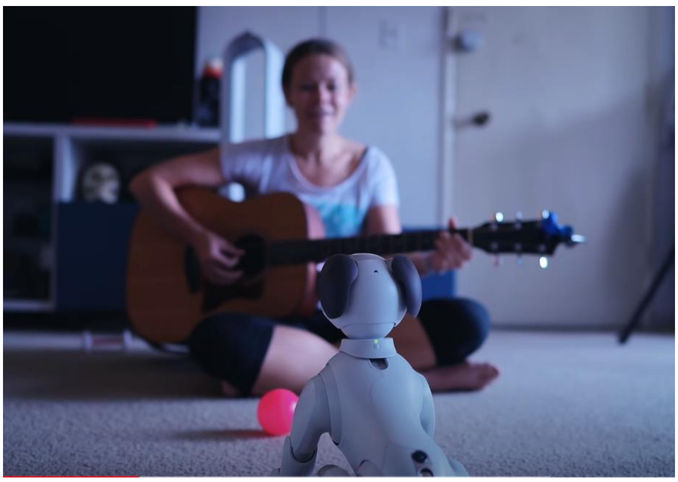
A: Paro (source: Wada & Shibata., 2007)

B: MiRo (source: Mitchinson & Prescott., 2016)

C: Aibo (source: https://us.aibo.com/)

Table 5.4: Videos for the companion pet robots

Robot	**Videos used**	**Features illustrated**
Paro	 [https://www.youtube.com/watch?v=ppPLDEi82lg&t=552s] Length: 30 s, 3:23-3:53 Language: English, I subtitled in Chinese for the study	Companion older people Response to touch

MiRo	 [url: https://www.youtube.com/watch?v=uBLBxqkvvL4] Length: 7s, 0:05-0:12 Language: English, I subtitled in Chinese for the study  [https://www.youtube.com/watch?v=cVQ2NSYG3hM] Length: 23s, 0:18-0:41 Language: English, I subtitled in Chinese for the study	Movement Express emotions Circadian rhythm Interact with older people
Aibo	 [https://www.youtube.com/watch?v=5ifwGc-0mAY]	Doing exercise with people Sing songs with people Photography Movement

	Length: 30s, 0:00-0:10, 0:41-0:56, 1:20-1.24 Language: English, I subtitled in Chinese for the study	

For the task-oriented table robots I chose the robots ElliQ, iCat, and Nanguo. These three task-oriented table robots were chosen because they are representative of a range of task-oriented robots, with different features. ElliQ has a separate display screen. iCat can deliver different emotions through facial expressions. Nanguo has functions that align with the needs of older Chinese people, in that it can be connected to WeChat (Chinese instant messaging, social media, and mobile payment app).

ElliQ (Figure 5.2A) is a table robot from Intuition Robotics, that is specifically developed to help older people. It can communicate with older people and respond to requests such as for weather information and news. ElliQ can also remind older people about daily routines and alert their family members when it changes; for example, when the indoor temperature is lower than normal, the robot will send this information to family members. (ElliQ, 2021).

iCat (Figure 5.2B) is a table robot, which looks somewhat like a cat, and can show different apparent emotions through facial expressions, such as happiness, anger, or sadness (De Ruyter, Saini, Markopoulos, & Van Breemen, 2005).

Nanguo (Figure 5.2C) is a table robot that can respond to requests, such as news and weather; it also can play music and connect to WeChat.

All three videos were chosen from YouTube to show the different features that task-oriented table robots could achieve and how older people could interact with them. Table 5.5summarizes the videos used for the task-oriented table robots.

A **B** **C**

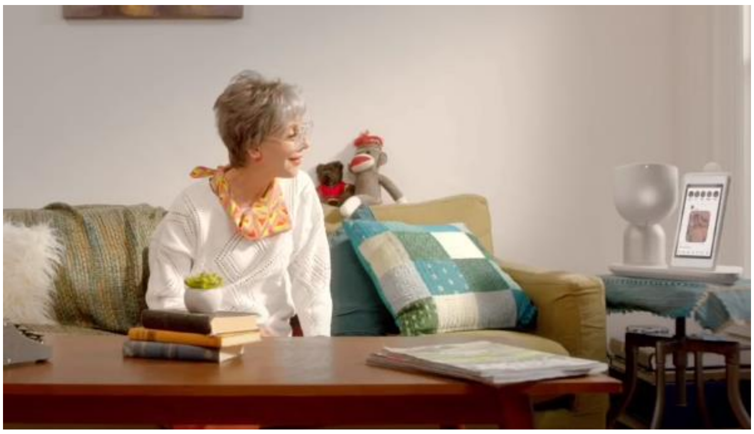
Figure 5.2: Task-oriented table robots (A: ElliQ, B: iCat, C: Nanguo)

A: ElliQ (Source: https://elliq.com/)

B iCat (Source:De Ruyter, Saini, Markopoulos, & Van Breemen, 2005).

C Nanguo (Source: https://www.youtube.com/watch?v=jFC1wcZv74A)

Table 5.5: Videos for the task-oriented table robots

Robot	**Videos used**	**Features illustrated**
ElliQ	 [https://www.youtube.com/watch?v=dDZAOro2BLo] Length: 45s, 0:38-0:54, 1:05-1:33 Language: English, I subtitled in Chinese for the study	Reminder functions Communication Video call with others through ElliQ Remote monitoring of house situation

iCat	 [https://www.youtube.com/watch?v=SgxdxP0UxwQ] Length: 45s, 0:45-1:27 Language: English, I subtitled in Chinese for the study	Communication Facial express emotions Play games with people
Aibo	 [https://www.youtube.com/watch?v=jFC1wcZv74A&t=24s] Length: 45s, 1:26-1:40, 2:37-2:50, 3:20-3:50 Language: Chinese	Connect to the WeChat Send a WeChat voice message Language translation function Play Music Voice control Ask and answers questions

For the task-oriented movement robots I chose Zenbo, Sanbot, and Pepper. These three robots were chosen because they are representative of a range of task-oriented movement robots, with different features. Zenbo's appearance is simple, without elaborated design, such as a separate head and arms, its head doubles as the display screen. The appearance of Sanbot is like a machine, but it also has human-like characteristics, such having head and moveable arms. Pepper is the most human-like robot and can do some human-like activities, such as twisting its body to dance.

Zenbo (Figure 5.3A) is a home assistive robot with an anthropomorphic face, developed by the Taiwanese electronics manufacturer Asus. It can talk, control the user's home and provide assistance when needed, such as reminding people to take their medication on time, make calls, and search for online information (ASUS Zenbo, 2021).

Sanbot (Figure 5.3B) is a robot developed by QIHAN Technology. It has an anthropomorphic face that can express different emotions. Sanbot can communicate with people, make video calls. (Sanbot robotics, 2021).

Pepper (Figure 5.3C) is a humanoid robot developed by SoftBank Robotics, it can communicate and perceive emotions. Pepper shaped like a human, it can talk, gesticulate, and entertain, for example by dancing with users (Softbank Robotics, 2021).

Videos were chosen from YouTube to show the different features that task-oriented movement robots could achieve and how older people could interact with them. Among them, the Pepper robot, I selected two YouTube videos and edited them together into one video. Table 5.6 summarizes the videos for the task-oriented movement robots.

A **B** **C**

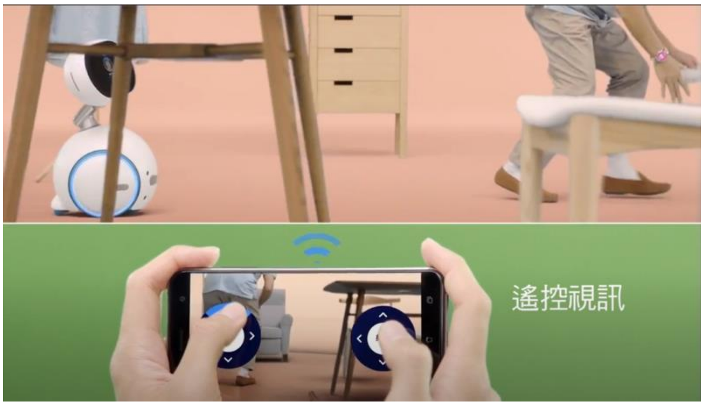
Figure 5.3: Task-oriented movement robots (A: Zenbo, B: Sanbot, C: Pepper)

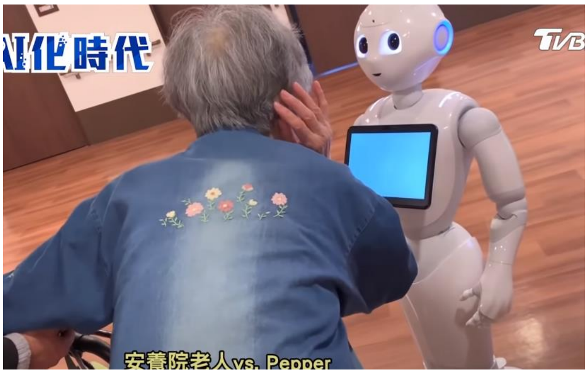
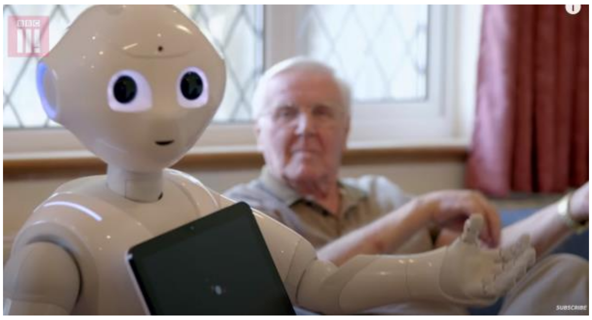
A: Zenbo (Source: https://zenbo.asus.com/)

B: Sanbot (Source: http://www.sanbot.com/index.html)

C: Pepper (Source: https://us.softbankrobotics.com/pepper)

Table 5.6: Videos for the task-oriented movement robots

Robot	**Videos used**	**Features illustrated**
Zenbo	 [https://www.youtube.com/watch?v=lDvwkFytgjc&t=24s] Length: 45s, 1:30-2:15 Language: Chinese	Communication Make an appointment and buy medicines. Fall detection and sending messages to family members Remote control Zenbo Emotion expression
Sanbot	 [https://www.youtube.com/watch?v=7Febrt0jerc] Length: 45s, 0:00- 0:43 Language: English, I subtitled in Chinese for the study	Communication Health monitoring and sending messages to family members Video call through Sanbot

Pepper	 [https://www.youtube.com/watch?v=Yr9i4jeudo4&t=1s] Length: 45s, 1:15 - 1:28, 4:45 – 5.03, Language: Chinese  [https://www.youtube.com/watch?v=XuwP5iOB-gs&t=22s] Length: 45s, 1:10 - 1:15, 1:20-1:26 Language: English, I subtitled in Chinese for the study	Communication Dance and play music for older people

5.2.3.2 Equipment

All interviews were recorded using an iPad voice record system for later analysis, and some interviews were also recorded using GoPro (action cameras) if participants were happy to be video recorded.

All three videos were played on a laptop in both the individual and group interviews.

5.2.4 Interview Schedule

All documents were prepared in English and then I translated them into Chinese and they were checked by another native speaker of Chinese (a Ph.D. student at the University of York), who is fluent in English and Chinese.

The same schedule with minor variations was used for both the individual (online and face-to-face) and group interviews.

The first section is the introductory section to relax the participants and get to know them. This section included general questions about the interviewee's day. In individual interviews, I would ask more questions about the interviewee's day to get to know the participants; but in group interviews, I would omit some questions because participants might not want to reveal much personal information in front of strangers. Then I then asked some general questions about robots to connect to the main interview and to understand the participants' knowledge of robots. The group interviews followed the same process, but in the group interviews I did not ask as many questions, to respect the participants' privacy.

The second section was about the three robot types (companion pet robots, task-oriented table robots, and task-oriented movement robots). I gave the participants some prompts about what questions would be asked about the video before participants watched the video (see Pilot Study, section 5.2.5). Then, participants watched the robot videos, the order of presentation was counterbalanced. After each video, I explored participants' attitudes towards each robot type by asking them if they would be happy to have this type of robot. For example, I asked participants: "Would you be happy to have one of these pet robots?" And then investigated their expectations about such robot type by discussing what they would want the robots to do or what they would want to do with the robots. For example, I asked them: “What would you like to do with it?” Finally, I asked to participants to rank the three robots shown in the video in order of preference.

The third section was about participants’ preferences for the three different robot types, and their expectations about robots in general. I summarized the three types of robots again and to prompt participants’ memories about the different types. After that, the participants were asked to choose which type of robot they preferred most and least. Then, they were asked to discuss what they would want robots to do for them regardless of robot type.

Participants' basic demographic information was collected in the final section, such as their gender and age.

For the online interview, I could not get the participants' instant feedback as they watched the videos, and the interviews were interrupted for a while because the participants needed to watch the videos which I sent them during the interviews. But in face-to-face interviews, I was able to get more information about their reactions and comments about the robot when they watched the video.

The full interview schedule is given in Appendix E

5.2.5 Pilot study

A pilot study was conducted to ensure the online interviews were suitable in terms of difficulty, comprehension, and length. The same two older Chinese people who conducted the pilot of Study 1, piloted the materials for this study. The interview schedule was revised based on the results of the pilot study. It was not thought necessary to do a separate pilot study for the face-to-face interview schedule.

In the initial interview schedule participants first watched the robot video, then I would ask their attitudes about the robot shown in the video. However, the pilot study participants forgot parts of the content in the video. Thus, I changed the schedule to give prompts about what questions would be asked before participants watched the video instead of just asking questions afterwards. In addition, in the third section of the interview on exploring preferences for different robot types and expectations for the robots, the pilot study participants forgot the robot types and so some of the video again. Thus, before I started the third section of the interview, I summarized the three types of robots again and to prompt participants' memories about the different types.

5.2.6 Procedure

The study received ethical approval from the Physical Sciences Ethics Committee of the University of York.

For the individual interviews, 21 participants were interviewed online via WeChat, and 6 participants were interviewed face-to-face in participants' home. All individual interview participants (both online and face-to-face) took part in the interview either individually or with their spouse. If two people participated in one interview, both were asked to answer the questions separately and give their own opinions. In addition, I explained that they did not have to avoid disagreements but were also allowed to agree. Potential individual interview participants were contacted through the WeChat message service and asked if they would participate in the study. If they were willing to participate, a suitable time slot for the interview was scheduled.

The group interviews took place in the community activity centre for older people in Hefei. The 26 participants were divided into 4 groups (Table 5.2). The activity centre staff helped me contact participants who met the criteria, and then participants were interviewed in the activity rehearsal room. In the group interviews I asked each of questions, and got people to answer them. And I tried to make sure that everyone answered.

The face-to-face individual and group interviews started with building rapport, I introduced myself, and my research. Then, I gave a brief introduction to the interview and gave them an information sheet detailing the study and what they would be asked to do. For the online interviews, I sent them an information sheet before the interviews.

Then, all interview participants were also asked permission to record the interview. They had the chance to ask questions before give verbal consent in the voice recording showing they understood and consented to be part of the study. Signing the online consent form is complex for older people, so instead I asked them to give verbal consent. The same procedure was followed for both the online and face-to-face interviews. Participant data in the study was anonymous, and each participant was assigned a code number. Participants could ask questions at any time or withdraw from the study. I would delete their data using their code if they wanted to withdraw from the study.

The main interview session started with introductory section to relax the participants and get to know them. Then, for the online interviews, I sent the robot videos to participants through WeChat. After they watched each robot type's video, I asked them question about that robot type (I went through the schedule as described in Section 5.2.4). For the face-to-face individual and group interviews, participants were asked to watch each robot type's video on my laptop, then, I asked them question about that robot type (I followed the flow of the schedule). Participants watched the robot videos in counterbalanced order (Table 5.1).

Participants had the opportunity to raise any remaining questions related to the research at the end of the interviews.

Online (including video-watching time) and face-to-face individual interviews took approximately half an hour; face-to-face group interviews took a few minutes longer than the individual interviews. All interviews were conducted in Chinese, the native language of the participants.

5.2.7 Data collection and analysis

All interviews and focus groups were voice recorded. Then, I transcribed each recording verbatim in Chinese and translated it into English.

All material from the interviews and focus groups were coded using NVivo (NVivo, 2021). Thematic analysis (Braun and Clarke., 2006) was used analyse the qualitative data, analysis methods and steps of thematic analyses were same with previous studies (Chapter 4.2.7).

The chi-square goodness-of-fit test was used to analyse the results of categorical data.

5.3. Results

My original intention was to analyse the data from each of the data collection methods (face-to-face interviews, online interviews, group interviews) and compare the results both about robots and about the data collection methods. However, analysis of the distribution of participants (see Table 5.1) showed an imbalance in age distribution between the three methods. All but one of the participants in the online interview group were between 60 and 69 years old, whereas over 80% of participants in the face-to-face interviews were 70 years or older, and over 60% of participants who took part in group interviews were 70 years and older. Thus, age was confounded with method. Any differences between methods could equally be due to the age differences of the participants in each method.

Therefore, in this section I present results from all three methods together along with age differences, although I realise there may be differences in the data due to the method of data collection. However, I did analyse the age difference rather than the difference between the methods. The participants in their 60s are the "young older" people, and those 70 and older are the "old older" people. In addition, given the relatively even split between participants in their 60s and those older, the two age groups are not too different in sample size, which is good for making comparisons. Thus, the age groups used were participants in their 60s (31, 58.5% of the sample) and those aged 70 and above (22, 41.51%).

5.3.1 Older Chinese people's attitudes toward the three different robot types

RQ1 investigated older Chinese people's attitudes toward three different robot types (companion pet robots, task-oriented table robots, and task-oriented movement robots) by exploring whether they want to have these robot types. Table 5.7 shows the number of participants willing to have such a robot and those not willing.

In relation to companion pet robots, there was no significant difference between the number of participants willing to have such a robot or not (X^2 (1) = 2.28, p = 0.13). However, there was a significant difference between the two age groups ($\chi2(1) = 12.82$, $p < .001$), participants in their 60s were significantly more willing to have a companion pet robot than not ($\chi2(1) = 11.65$, $p < .001$) whereas for participants in their 70s and older, there was no significant difference between those willing to have such a robot and not ($\chi2(1) = 2.91$, n.s.).

With respect to participants' attitudes toward the task-oriented table robots. There was a significant difference between the number of participants willing to have such a robot or not ($X^2(1) = 28.70$, $p < .001$). There was no significant difference between the two age groups ($\chi2(1) = 0.81$, p = 0.37, n.s).

For the task-oriented movement robots, there was a significant difference between the number of participants willing to have such a robot or not participants ($\chi2(1) = 18.13$, $p < .001$). There was also no significant difference between two age groups ($\chi2(1) = 0.15$, $p = 0.70$, n.s).

In relation to participants' interest in having the different robot types, there was a significant difference in the number of participants' willing to have each robot type (Cochran's Q = 13.00, p = 0.002). Participants were significantly more willing to have either type of task-oriented robot compared to a pet robot (companion pet robot vs task-oriented table robot: Bonferroni post hoc = - 0.264, p < .001; companion pet robot vs task-oriented movement robot: Bonferroni post hoc = - 0.189, p = 0.01). There was no significant difference in their willingness to have either kind of task-oriented robot (Bonferroni post hoc = 0.08, p = 0.32, n.s).

For participants in their 60s, there was no significant difference in their interest in having three robot types (Cochran's Q = 2.17, p = 0.34). But for participants in their 70s and older, there was significant difference (Cochran's Q = 20.17, p < .001). Participants in this age group was more willing to have either type of task-oriented robot compared to a pet robot (Bonferroni post hoc = 0.50, p < .001 in both cases).

In summary, older Chinese people show a willingness to have all three robot types., There is a significant difference in their willingness to have the three different robot types. The willingness to have companion pet robots are significantly less than task-oriented table robots and task-oriented movement robots, respectively. Similarly, Chinese people aged 70 and older show significantly less willingness to have companion pet robots than task-oriented table robots and task-oriented movement robots, respectively. On the other hand, there was no significant difference in willingness to have three robot types among older Chinese people aged in the 60s.

Table 5.7: Older Chinese participants interest in having three different robot types

		Age group		
		60s N=31	**70 and above** N=22	**Total** N=53
Companion pet	Willing to	25, 80.65%	7, 31.82%	32, 60.38%

robots	have			
	Not willing to have	6, 19.35%	15, 68.12%	21, 39.62%
Task-oriented table robots	Willing to have	28, 90.32%	18, 81.82%	46, 86.79%
	Not Willing to have	3, 9.68%	4, 18.18%	7, 13.21%
Task-oriented movement robots	Willing to have	24, 77.42%	18, 81.82%	42, 79.25%
	Not Willingness to have	7, 22.58%	4, 18.18%	11, 20.75%

5.3.2 Older Chinese people's preferences for the three robot types

RQ2 investigated older Chinese people's preferences for the three robot types (companion pet robots, task-oriented table robots, task-oriented movement robots). Results are summarized in Table 5.8. 50 participants expressed their opinions on which type of robot was their most preferred, while three participants (all in the 70 and above group) did not answer this question. 49 participants discussed their second and least preferred robot types, while four participants did not express their opinions (60s group: N=1, 70 and above group: N=3). Participants who did not give an opinion were excluded from the subsequent analysis.

Table 5.8: Older Chinese participants preference of different robot types

	Age groups		
First preference	**60s**	**70 and above**	**Total**

	60s	70 and above	Total
	(N=31)	(N=19)	(N=50)
Companion pet robots	4, 12.90%	0	4, 8.0%
Task-oriented table robots	9, 29.03%	1, 5.26%	10, 20.0%
Task-oriented movement robots	18, 58.06%	18, 94.74%	36, 72.0%
Second preference	**60s**	**70 and above**	**Total**
	(N=30)	(N=19)	(N=49)
Companion pet robots	15, 50.0%	1, 5.26%	16, 32.65%
Task-oriented table robots	8, 26.67%	17, 89.47%	25, 51.02%
Task-oriented movement robots	7, 23.34%	1, 5.26%	8, 16.33%
Third preference	**60s**	**70 and above**	**Total**
	(N=30)	(N=19)	(N=49)
Companion pet robots	11, 36.67%	18, 94.74%	29, 59.18%
Task-oriented table robots	14, 46.67%	1, 5.26%	15, 30.61%
Task-oriented movement robots	5, 16.67%	0	5, 10.20%

In terms to the type of robot that participants preferred most (N=50), participants preferred task-oriented movement robots significantly more ($\chi2(2) = 34.72$, $p < .001$). There was also a significant difference between two age groups ($\chi2(2) = 7.98$, $p = 0.02$). In 60s age group (N=31), participants preferred task-oriented movement robots significantly more ($\chi2(2) = 9.74$, $p = .008$). In the age group of 70 and above (N=19), participants preferred task-oriented movement robots significantly more than others ($\chi2(1) = 15.21$, $p < .001$). Although both age groups of participants prefer task-oriented movement robots, compared with the participants in the 60s age group, the preferences of the participants in the 70 above age group are more extreme, with all but one participant preferring a task-oriented movement robot (Table 5.8).

Participants gave several reasons for they chose task-oriented movement robots as their most preferred robot type, which is that they are humanoid, practical, have many functions, and can be movable. As one participant said:

> It’s practical and movable, which is not fixed like a task-oriented table robot. (P14, female, 68 years old)

Regarding the reasons participants preferred task-oriented table robots, participants commented that they are practical, could communicate with them, and the size is appropriate. One participant commented:

> Table robots, the robot’s size is small and doesn't take up space. Large robots take up too much space. (P33, female, 63 years old)

In terms of companion pet robots, participants indicated that this type of robot could entertain and interact with them. For example, one participant said:

> I like to interact with them, play and touch them. (P38, female, 63 years old)

In terms of the second preferred robot type (N=49), the there was a significant difference between participants’ preferred robot type ($\chi2(2) = 8.86$, $p = 0.01$), with participants preferring task-oriented table robots significantly more. There was also a significant difference between two age groups: ($\chi2(2) = 18.45$, $p < .001$). In 60s age group (N=30), there was no significant difference in their second preferred robot type ($\chi2(2) = 3.80$, $p = 0.15$). However, in 70 and above age group (N=19), the task-oriented table robots was significantly more often chosen as the second preferred robot type ($\chi2(1) = 15.21$, $p < .001$).

The majority of participants chose task-oriented table robots as their second preferred robot type, and they gave reasons to explain, that this type of robot has practical functions, could interact with them, and could communicate with them. As one participant put it:

> I can interact with it, and it can reminder to take medicine and other things. (P46, male, 68 years old)

In addition, participants chose the companion pet robot as their second preference because this type of robot is cute and mobile, which can add fun to their life, but may not be functionally as good as the robot type they chose as most preferred. As one participant put it:

> It can add to the pleasure of life. (P10, female, 68 years old)

Of the 49 participants who expressed their opinions of their least preferred robot types, there was a significant difference in their least preferred robot types ($\chi2(2) = 17.80$, $p < .001$), with companion pet robots as participants' least preferred robot type. There was also shows a significant difference between the two age groups ($\chi2(2) = 16.31$, $p < .001$). In 60s age group (N=30), there was no significant difference in their least preferred robot types ($\chi2(2) = 4.20$, $p = 0.12$). But in 70 and above age group (N=19), there was a significant difference in their least preferred robot types ($\chi2(1) = 15.21$, $p < .001$), with companion pet robots as their least preferred option.

The reason participants chose companion pet robots as their least preferred robot type is that they felt this robot type is useless, and some participants do not like animals. One participant commented:

> Companion pet robots are not practical (P13, male, 68 years old)

In terms of the task-oriented table robots, the lack of ability to move and less interaction were mentioned by participants to explain why they do not like them. One participant stated that:

> This type of robot cannot move, which is inconvenient; it can only communicate with us. (P8, female, 68 years old)

For the task-oriented movement robots, space limitation was the only reason they chose this robot type as their least preference. One participant commented:

> My home is not big enough (to use this type of robot). (P33, female, 62 years old)

5.3.2.2 Preference of companion pet robots

I showed participants three different companion pet robots in the video, and then, participants ranked their preferences for these robots. The majority of participants aged over 70 indicated that they do not really like this robot type, so, they did not discuss their preferences (Table 5.9).

Therefore, I only analyzed the 60s age group’s data on their preference for companion pet robots. 29 participants in the 60s age group (2 participants did not give their opinion on this topic) discussed their opinions about the companion pet robots, 29 of them gave their opinions on the most preferred companion pet robots, 26 of them discussed the second preferred robots, and 27 of them discussed their least preferred robot. Participants who did not give an opinion were excluded from the subsequent analysis.

Table 5.9: Older Chinese participants preferences for companion pet robots

	Age groups		
First preference	**60s** (N=29)	**70 and above** (N=1)	**Total** (N=30)
Paro	3, 10.35%	0	3, 10.0%
MiRo	1, 3.45%	0	1, 3.33%
Aibo	25, 86.21%	1, 100.0%	26, 86.67%
Second preference	**60s** (N=26)	**70 and above** (N=1)	**Total** (N=27)
Paro	5, 19.23%	0	5, 18.52%
MiRo	20, 76.92%	1, 100.0%	21, 77.78%
Aibo	1, 3.85%	0	1, 3.70%
Third preference	**60s** (N=27)	**70 and above** (N=8)	**Total** (N=35)
Paro	21, 77.78%	8, 100.0%	29, 82.86%
MiRo	6, 22.22%	0	6, 17.14%
Aibo	0	0	0

For the most preferred companion pet robots for the 60s age group (N=29), there was a significant difference the most preferred companion pet robots ($\chi 2(2) = 38.69$, $p < .001$), with Aibo as clearly the most preferred. Participants stated a number of reasons why they liked Aibo, such as appropriate size, movable, multifunction, interaction, and companionship. One participant stated that:

> Aibo is similar to the puppy, which can interact with people. (P17, female, 68 years old)

And another commented:

> It could run (move). (P14 female, 68 years old)

In terms to the second preferred companion pet robots (N=26), there was a significant difference in the distribution of their second preferred companion pet robots ($\chi2(2) = 26.15$, $p < .001$), with MiRo clearly the participants' second preferred companion pet robot. Participants indicated that although MiRo could interact with people, although it seems less interactive with people than Aibo. As one participant put it:

> This can only be played with older people, and less interaction with people. (P45, female, 63 years old).

There was also a significant difference in the least preferred companion pet robots ($\chi2(1) = 8.33$, $p = 0.004$), with Paro clearly the least preferred option. reasons participants chose Paro as their least preferred companion pet robot was that it was immovable, useless, provided less interaction, and participant did not like furry things. In terms of the MiRo, some participants felt that it is useless and looks like a toy. One participant commented:

> It can’t move, and like a doll. (P31, male, 64 years old)

5.3.2.3 Preference of task-oriented table robots

Regarding the preference for task-oriented table robots, 44 participants discussed the topic and gave their opinions (Table 5.10). All of them discussed their most preferred task-oriented robots, 26 of them discussed their second preferred robot, and 27 discussed their least preferred robot. Participants who did not give an opinion were excluded from the subsequent analysis.

Table 5.10: Older Chinese participants preferences for task-oriented table robots

	Age group		
First preference	**60s**	**70 and above**	**Total**

	60s (N=30)	70 and above (N=14)	Total (N=44)
ElliQ	12, 40%	2, 14.29%	14, 31.18%
iCat	1, 3.33%	3, 21.43%	4, 9.10%
Nanguo	17, 56.67%	9, 64.29%	26, 59.10%
Second preference	**60s**	**70 and above**	**Total**
	(N=24)	(N=2)	(N=26)
ElliQ	8, 33.33%	0	8, 30.77%
iCat	6, 25.0%	1, 50.0%	7, 26.92%
Nanguo	10, 41.67	1, 50.0%	11, 42.31%
Third preference	**60s**	**70 and above**	**Total**
	(N=25)	(N=2)	(N=27)
ElliQ	5, 20.0%	1, 50.0%	6, 22.22%
iCat	17, 68.0%	1, 50.0%	18, 66.67%
Nanguo	3, 12.0%	0	3, 11.11%

In terms to the participants' most preference (N=44), there was a significant difference in the distribution of their most preferred task-oriented table robots ($\chi2(2) = 16.55$, $p < .001$), with Nanguo clearly the most preferred. There was a significant difference between the two age groups ($\chi2(2) = 5.52$, $p = 0.06$). In the 60s age group (N=30), participants preferred Nanguo significantly more than the others ($\chi2(2) = 13.40$, $p = .001$). In the 70 and above group (N=14), participants still preferred Nanguo significantly more than the others ($\chi2(2) = 6.14$, $p = .046$). Although the majority of participants from the two age groups chose Nanguo as their most preferred task-oriented table robot, the distribution of the participants who chose ElliQ and iCat is different between the two age groups. Participants in the 60s age group preferred ElliQ more than iCat, while participants in the 70 above group preferred iCat more than ElliQ.

Regarding reasons why participants preferred Nanguo most, were that they felt that Nanguo is practical, that they could interact with it, and it could communicate and answer questions in Chinese, it also could help them to connect with others through WeChat and entertain them. As one participant put it:

> The third one is very practical because I can use WeChat. (P52, male, 65 years old)

In terms of ElliQ, participants mentioned that it has a screen and has reminder and home monitoring functions, it also could help them to connect with others. For example, one participant said:

> The first one could remind me to take medicine. (P30, female, 70 years old)

The iCat has facial features, which was the only reason cause participants chose it as their favourite companion pet robot. One participant stated that:

> It has a nose and eyes, which have senses. (P18, male, 75 years old)

For the second and least preference of task-oriented table robots, the majority of participants aged over 70 years only chose their most preferred task-oriented table robots and thought there was no difference between the remaining two robots that were shown in the video (Table 5.10). Therefore, the analysis of the middle and least preferred task-oriented table robot will only analyse the data from the 60s age group.

For participants who gave a second preferred task-oriented table robot (N=24), there was no significant difference in the distribution of the middle preference of task-oriented table robots ($\chi2(2) = 1.00$, $p = 0.61$).

Participants gave positive and negative reasons for why they chose Nanguo as the second position. They indicated that it has many functions, but those functions could be replaced by smartphones. As one participant said:

> The third one is a bit like a voice-only function. Now our smartphones can do this, and I can talk to my smartphone. So, it was replaced by smartphones. I can also convert the voice into text. The mobile phone already has this function. Now, this one is not necessary" (P40, female, 64 years old).

Regarding the participants' least preferred task-oriented table robot (N=25), there was a significant difference in their least preference for task-oriented table robots ($\chi2(2) = 13.76$, $p = .001$), with iCat as participant's most frequently chosen least preferred task-oriented table robot.

The reasons of participants did not like iCat, was that they did not like playing games with robots, and they felt it is useless and dumb. As one participant put it:

> I don't like playing games, and it has no functions and is not practical. (P31, male, 64 years old)

In terms of ElliQ, the small screen, and lack of useful functions were given as the reasons that caused participants to choose ElliQ as the least preferred task-oriented table robot. One participant reported that:

> The first one is just a reminder that it is not as functional as the other two. (P50, male, 61 years old)

For the Nanguo, participants indicated that smartphones could replace its functions. One participant said:

> Some functions can be replaced by smartphones. (P34, male, 63 years old)

5.3.2.4 Preference of task-oriented movement robots

Regarding preferences for task-oriented movement robots, 50 participants discussed the topic and gave their opinions (Table 5.11); all of them discussed their most preferred task-oriented movement robots, and 25 of them gave opinions about second and third preferences. Participants who did not give an opinion were excluded from the subsequent analysis.

Table 5.11: Older Chinese participants preferences for task-oriented movement robots

	Age groups		
Most preference	**60s** (N=31)	**70 and above** (N=19)	**Total** (N=50)
Zenbo	10, 32.36%	1, 5.26%	11, 22.0%
Sanbot	10, 32.36%	0	10, 20.0%
Pepper	11, 35.48%	18, 94.74%	29, 58.0%
Second preference	**60s**	**70 and above**	**Total**

	60s	70 and above	Total
	(N=24)	(N=1)	(N=25)
Zenbo	10, 41.67%	1, 100.0%	11, 44.0%
Sanbot	6, 25.0%	0	6, 24.0%
Pepper	8, 33.33%	0	8, 32.0%
Least preference	**60s**	**70 and above**	**Total**
	(N=24)	(N=1)	(N=25)
Zenbo	4, 16.67%	0	4, 16.0%
Sanbot	13, 54.17%	1, 100.0%	14, 56.0%
Pepper	7, 29.17%	0	7, 28.0%

In relation to the most preferred task-oriented movement robots (N=50), there was a significant difference in preferences for task-oriented movement robots ($\chi 2(2) = 13.72$, $p = .001$), with Pepper clearly the most preferred. In addition, there was a significant difference between the two age groups ($\chi 2(2) = 17.16$, $p < .001$). In the 60s age group (N=31), there was no significant difference in preferences ($\chi 2(2) = 0.07$, $p = 0.97$, n.s). However, in the 70 and above age group (N=19), there was a significant difference ($\chi 2(1) = 15.21$, $p < .001$), with Pepper as the most preferred task-oriented movement robot.

Participants stated a number of reasons to explain they chose Pepper as their most preferred robot; they thought Pepper is humanoid and has many functions, which could entertain them, communicate and interact with them. One participant reported that:

> It's more human-like, so I think its functions would be more comprehensive. (P5, female, 70 years old)

In terms of the Zenbo, participants felt that it is practical, that it could do housework and has health care functions, such as health monitoring and providing alarms. One participant stated that:

> I like the first one, because children are not around, it can alarm. (P38, female, 63 years old)

The reasons participants chose Sanbot as their most preferred task-oriented movement robot are similar to Zenbo, that it is practical and can provide health care functions. One participant said:

> The second one [Sanbot] can monitor heard rate and blood pressure. (P47, female, 60 years old).

Many participants only chose their most preferred task-oriented movement robots, especially in the 70s above group, and they thought there was no difference between the remaining two robot examples; thus, only 25 participants (including only one in the 70 and above group gave their opinions on the middle and least preferred task-oriented movement robots (Table 5.11). Therefore, the 70s above group was excluded from further analysis of the second and least preference for task-oriented movement robots.

In terms to the participants' second preferred task-oriented movement robots (N=24), there was no significant difference in the distribution of their middle preference for task-oriented movement robots ($\chi2(2) = 1.00$, $p = 0.61$, n.s).

In terms of participants' least preferred task-oriented movement robots (N=24), there was also no significant difference in the distribution of their least preference for task-oriented movement robots ($\chi2(2) = 5.25$, $p = 0.07$, n.s).

The reasons participants chose particular robots as their least preferred task-oriented movement robot were similar for the different robots. For Sanbot, participants thought it has fewer functions, that it is useless; its size is small, and it looks like a machine. In addition, participants felt that Sanbot is helping older people's family members to monitor older people rather than helping older people. As one participant put it:

> It feels like helping family members to monitor the older people, which place secondary position for me. What I want most is a robot that can help me. What I hope most is that the robot can help me with the housework. (P43, male, 60 years old)

Regarding Pepper, three reasons were mentioned by participants, which are that it had less functions, they do not need it, and they do not like dancing (Pepper dancing with older people is shown in the video). One participant stated that:

> I didn't see its function, just to interact with older people. (P50, male, 61 years old)

For the Zenbo, participants also mentioned three reasons, which are less functions, it looks like a machine, and its small size. One participant said:

> The first one’s function is too monotonous, the function of delivering medicine is too monotonous. (P34, male, 63 years old)

5.3.3 Older Chinese people’s expectations about personal robots in general, and the three robot types in particular

RQ3 investigated older Chinese people’s expectations about the three robot types in particular (companion pet robots, task-oriented table robots, and task-oriented movement robots), as well as their expectations about personal robots in general. Thematic analysis was used to summarize participants' expectations of different robot types, and their expectations of robots in general, regardless of robot type. The following sections will discuss the participants' expectations for companion pet robots, task-oriented table robots, and task-oriented movement robots, respectively. Then, this section will discuss the characteristics they want the robot to have and the functions that they hope robots could be achieved, regardless of the robot type.

Table 5.12 presents the thematic analysis which resulted in eight themes, with 30 sub-themes. Then, Table 5.13 presents the participants’ expectations for the different robot types.

Table 5.12: Definitions of the themes relating to older Chinese participants’ expectations about personal robots

Theme	Sub-theme	Definition	Examples
Overall robot characteristics	Human-like appearance/behaviour	Behaviour and/or appearance human like	It can shake hands and communicate, like a grandson (P41, male, 66 years old, task-oriented movement robots)
	Animal-like	Having the	It looks like a puppy (P50,

	appearance/behaviour	appearance or behaviour of an animal, either mentioned as in general animal-like or referring to a specific animal	male, 60 years old, companion pet robots)
	Multifunctional	Robots should have many functions	It's better if it has more functions (P50, male, 61 years old, companion pet robot) It is best for the robot to be able to do everything, all functions are brought together (P50, male, 61 years old, task-oriented movement robots)
	Simple functionality	Functions should be simple not complex	The function is simple (P13, male, 68 years old, task-oriented table robots)
	Mobility	Robots should be able to move autonomously	I want such type of robot [that] could be able to run (P14, female, 58 years old, companion pet robots)
Overall expectation	Positive expectation	Participants' positive	I think it will be very cute when interacting with

		expectations and desire to use robots in the future.	people (P50, male, 60 years old, companion pet robots)
Interaction method	Voice interaction	Users should be able to interact with a robot via voice	It can … communicate, like a grandson (P41, male, 66 years old, task-oriented movement robots)
	Speak Chinese	Robot should be able to interact in Chinese	… but it is best to communicate in Chinese … older Chinese people have limited foreign language proficiency (P1, male, 70 years old, task-oriented table robots)
Usability	Easy to use	Interacting with and controlling robots should be simple	The program (robots) should be simple and easy to operate. (P1, mal, 70 years old, robots in general)
	Useful	Robots are useful and have many practical functions	We want robots that are practical and flexible. (P15, female, 68 years old, robots in general)
Overall purpose	Taking care of older people	Take care of the daily life of older people like a caregiver.	I hope that the robot can be designed more comprehensively, nothing is difficult for them, it can take care of

			our daily lives, and can do everything. (P35, female, 62 years old, robots in general)
	Alleviate loneliness		If I had a companion pet robot like this, I would definitely want to interact with it. I will play with it and won't be lonely anymore when I am at home by myself. (P49, female, 62 years old, companion pet robots)
	Provide companionship	Robots could fulfil the emotional needs of older people by providing companionship.	There is a sense of companionship (P34, male, 63 years old, task-oriented table robots)
Task-Oriented Functionality	Doing domestic tasks	Robots should be able to perform household tasks such as cleaning, doing laundry,	I hope that the robot can help me with housework, cleaning, cooking, washing and drying, etc (P40, female, 64 years old, robots in general)
	Cooking	Cook meals	I hope the robot can help me, for example, it can help me to cooking. (P46, male, 68 years old, robots in general)

	Fetch objects	Fetch objects for the user.	I want robots could picking up objective. (P35, female, 62 years old, task-oriented movement robots)
	Navigation	Guide users to their destinations, in real-time	I hope the robot can navigate for us. It can prompt us and help us find our destination when we go out. (P8, female, 68 years old, task-oriented table robots)
	Exercise	Doing exercise with users	Doing exercise and singing together. If I had a companion pet robot like this, I would definitely want to interact with it. I will play with it and won't be lonely anymore when I am at home by myself. (P49, female, 62 years old, companion pet robots)
	Monitoring home safety	Monitor home security, e.g. intrusions by stranger, gas leaks	It can also monitor our home. (P51, male, 60 years old, task-oriented table robots)
	Contacting others	Robots should be able to support	I want it with a WeChat function and can make

		users in making voice and video calls (with apps such as WeChat)	video calls (P36, female, 61 years old, task-oriented table robots)
	Information access	Answering questions, support searching for information	Knowing the weather, news (P33, female, 62 years old, task-oriented table robots)
	Reminding	Remind the user of their schedule, physical condition, and home security	remind me to … get up and cook (P13, male, 68 years old, task-oriented table robots)
Companion-Oriented Functionality	Entertainment (active)	Robots should provide entertainment involving active participation by the user, e.g. dancing with the user, getting the user to sing, playing a game with the user	I hope it can play … sing with me (P32, female, 72 years old, task-oriented table robots) It's great to be able to … play games with them (P48, female, 85 years old, task-oriented movement robots)
	Entertainment (passive)	Robots should provide entertainment	it can play music (P13, male, 68 years old, task-oriented table robots)

		involving passive participation by the user, e.g. playing music, reading story, dancing alone	
	Communication	Robots should be able to engage in conversation with the user	There is a sense of companionship …. it can communicate with me (P34, male, 63 years old, task-oriented table robots) I hope it can … chat (P32, female, 72 years old, task-oriented table robots) It's great to be able to interact, talk, … with them (P48, female, 85 years old, task-oriented movement robots)
Healthcare-Oriented Functionality	Health Alarm	Raise alarm; remind users if there is a problem with their health. Notify others if needed	It could [raise the] alarm [with] others if I encounter something (P48, female, 85 years old, task-oriented movement robots)
	Health monitoring	Monitoring heart rate, blood pressure et	Blood pressure monitoring (P12, female, 68 years old, task-

			oriented table robots)
	Fall detection	Detecting fall and seeking help if needed	It can detect whether someone fell while at home. (P46, male, 68 years old, task-oriented movement robots)
	Medicine compliance	Ensuring compliance with medications, e.g. by providing reminders	remind me to take medicine (P13, male, 68 years old, task-oriented table robots)
	Support Medical consultations and prescription delivery	Medical consultation, giving prescriptions; then, helping users order corresponding drugs online, and then delivering them.	It could has the function of uploading prescriptions and delivering medicines. (P40, female, 64 years old, task-oriented movement robots)

Table 5.13: older Chinese participant's expectations of robots

Theme	**Sub-theme**	**Companion pet robots**	**Task-oriented table robots**	**Task-oriented movement robots**	**Robots in general**
Overall robot characteristics	Human-like appearance/behaviour	-	-	10	7
	Animal-like appearance/behaviour	9	-	-	-

	Multifunctional	2	9	9	7
	Simple functionality	-	2		
	Mobility	13		13	13
Overall expectation	Positive expectation	6	-	-	-
Interaction method	Voice interaction	-	5	1	-
	Speak Chinese	-	2	-	-
Usability	Easy to use	-	2	-	-
	Useful	2	8	7	2
Overall purpose	Taking care of older people	-	2	3	7
	Alleviate loneliness	-	-	2	1
	Provide companionship	7	3		3
Task-Oriented Functionality	Doing domestic tasks	-	1	10	13
	Cooking	-	-	1	7
	Fetch objects	-	-	2	1
	Navigation	-	1	-	-
	Exercise	5	-		--
	Monitoring home safety	-	4	6	-
	Contacting others	-	12	-	3
	Information access	--	14	3	6

	Reminding		14	-	6
Companion-Oriented Functionality	Entertainment (active)	12	15	6	5
	Entertainment (passive)	1	5	3	2
	Communication	18	17	17	6
Healthcare-Oriented Functionality	Health Alarm	-	5	24	7
	Health monitoring	-	3	13	7
	Fall detection	-	2	11	
	Medicine compliance	-	9	-	2
	Support Medical consultations and prescription delivery	-	3	7	-

5.3.3.1 Expectations about companion pet robots

Table 5.13 shows six themes that emerged in relation to participants' expectations about companion pet robots, which includes 10 sub-themes. Unsurprisingly, participants wanted such robots to have "Animal-like appearance/behaviour"; participants expected companion pet robots to look like real animals. In addition, participants mentioned the theme of "Overall expectation"; participants felt that the companion pet robots would be "Cute". As one participant said:

> Interacting with it and play games, it's cute. (P39, female, 60 years old)

It is worth noting that participants' expectations of companion pet robots are focused on the theme of "Companion-Oriented Functionality" (24 mentions), in addition, the sub-theme of

“Communication” was most frequently mentioned by participants (18 mentions) when they discussed their expectations of this robot type. Although the companion pet robots’ video did not show that it could communicate with older people, participants still mentioned this sub-theme very frequently.

On the other hand, surprisingly, compared with other robot types, participants mentioned only one sub-theme (Exercise) related to the theme of “Task-Oriented Functionality”. In addition, participants do not have any expectations about the theme of “Healthcare-Oriented Functionality” for this robot type.

5.3.3.2 Expectations for task-oriented table robots

In terms of the participants’ expectations for task-oriented table robots, seven themes emerged, which included 22 sub-themes. (Table 5.13). The most striking result to emerge for this robot type is that participants highlight the themes of “Interaction method” (7 of the 8 total mentions are on this theme) and “Usability” (10 of the 21 total mentions are on this theme) when compared with other robot types. Participants expected this type of robot to interact by voice and speak Chinese. In addition, participants want this robot type to be easy to use. Apart from that, compared with other robot types, three sub-themes were mentioned more by participants, which are “Contacting others” (12 mentions), “Information access” (14 mentions), and “Reminding” (14 mentions). Participants expected task-oriented table robots to help them contact others through WeChat (a Chinese instant messaging, social media, and mobile payment app), answer their questions, and remind them of their daily schedule. As one participant commented:

> Ask some daily questions, and help us to connect with family and friends. (P31, male, 64 years old)

In addition, the theme of “Healthcare-Oriented Functionality” was highlighted by participants; although each sub-theme was not mentioned the most by participants, all sub-themes that related to the theme were mentioned.

On the other hand, participants did not mention anything that related to the appearance of this robot when compared with other robot types, and they did not expect this robot type to move; participants only emphasised the functionality-related themes of this robot type.

5.3.3.3 Expectations for task-oriented movement robots

In terms of the participants’ expectations for task-oriented movement robots, seven themes emerged, which included 19 sub-themes. (Table 5.13). Unsurprisingly, participants wanted such robots to have “Human-like appearance/behaviour”, as one participant commented:

> It can shake hands and communication, like a grandson. (P41, male, 66 years old)

Many participants (10 mentions) mentioned the sub-theme of “Doing domestic tasks” compared with other robot types, this sub-theme was mentioned far more. Participants expected that this robot type could help them do chores like sweeping the floor and washing clothes. In addition, it is worth noting that the theme of “Healthcare-Oriented Functionality” was emphasised by participants; the sub-theme of “Health Alarm” was most frequently mentioned (24 mentions) when they talked about their expectations of task-oriented movement robots. In addition, compared with other robot types, the sub-theme of “Fall detection” was mentioned by participants more, although is probably because this function was shown in the video; they want this robot type to detect them if they fall at home, and take a series of measures to help the older person.

5.3.3.4 Expectations for robots in general

After discussing the participants' expectations for the three different types of robots, I asked participants to use their imaginations to discuss their expectations for robots in general instead of being limited to one particular type. Six themes emerged from this discussion (Table 5.13), which included 18 sub-themes. Interestingly, many participants mentioned the sub-theme of "Human-like appearance/behaviour", while no participants mentioned the sub-theme of "Animal-like appearance/behaviour". In addition, many participants emphasised the sub-theme of "Taking care of older people"; they expected that robots could take care of them like caregivers, which aligns with the fact that participants want robots with "Human-like appearance/behaviour".

Another striking sub-theme is "Cooking"; although the robot videos did not show any content that related to cooking, the theme was mentioned by participants spontaneously. It is noteworthy that it was only mentioned once in relation to a specific robot type (task-oriented movement robots), but seven times in the discussion of robots in general. They want robots to help them to cook meals.

On the other hand, compared with some expectations that related to the themes "Overall expectation" and "Interaction method" when they discussed particular the robot types, no participants mentioned these two themes spontaneously when they talked about their expectations of robots in general. Participants tended to focus on "Overall robot characteristics" and functionality-related aspects.

5.3.4 Negative comments and concerns about robots

Regarding RQ4 which investigated older Chinese people's concerns about robots, surprisingly, only seven participants expressed their opinions on this topic. There was no specific question about concerns, but the data was analysed for comments that people made about concerns. Two themes emerged in a thematic analysis (see Table 5.14), which are "Affordable" and "Too difficult to use". In terms of the theme of "Affordable", participants considered robots to be high-end technology products with multiple functions, especially when they talk about the task-oriented movement robots, they worried that the price of such robots would be expensive for them to afford. Regarding the "Too difficult to use" theme, participants worried that the robots might be complicated to operate and they may not be able to use them well.

Table 5.14: Older Chinese people's concerns about using robots

Concerns	Definition	Example quotes
Affordable (3, 42.86%)	Price should be reasonable and affordable for users	I'm worry about the price that may be expensive. (P51)
Too difficult to use (3, 42.86%)	Using robots would be free of effort.	I don't like these things. It's too difficult and high-end. I'm afraid that I can not use robots well. (P29)

Although participants did not have many concerns about robots, many participants (N=44) gave negative comments when they watched the videos, and when they explained the reasons why they did not prefer a particular robot type or robot. Table 5.15 shows 12 themes which a thematic analysis of these comments revealed were mentioned in this way by participants.

The theme of "Immovable" was most frequently mentioned by participants; they wanted the robot to be flexible and movable, especially when discussing Paro as the companion pet robot, but it cannot move like real pets. The themes of "Useless" and "Don't need it" was also usually mentioned by participants. Especially when participants discussed companion pet robots, they felt that such robots had no practical use or function. In addition, they commented that companion pet robots are suitable for older people who live alone, thus, they do not need such robots. In addition, participants also tended to relate their dislike of a certain type of robot or a specific robot to their "Appearance" when explaining why they did not like it; for example, they did not like furry things or robots that looked like toys.

Table 5.15: Characteristics of robots that older Chinese people dislike

Negative comments	Definition	Example quotes
Immovable (21, 47.73%)	Robots cannot be mobile, are stationery on the table.	The first one, it can't move and walk by itself; it can only be placed there, which is not good. (P50)
Useless (20, 45.45%)	Robots have no practical functions and are “flashy”.	The second one is not very useful. (P45)
Appearance (13, 29.55%)	The appearance of the robot is not satisfactory.	I don't like furry things (Paro) (P46).
Less interaction (12, 27.27%)	Robots lack interactivity, such as being able to interact only by voice and	The second one, it’s less interaction with older people. It can only talk

	not by other means.	with older people, and amuse the older adult, but I prefer the robot that can be interacted with. (P44)
Don’t need it (10, 22.73%)	Robots are not something users need to use in their daily lives.	It can only be said that it is suitable for lonely people. I don't really need this kind of robot at present. (P34)
Use requirements (Home space limitations) (8,18.18%)	Robots require certain use conditions, such as a large enough housing area.	This type of robot is too heavy and inconvenient to move, and my home is not big enough. (P33)
Less functions (8,18.18%)	Robots do not have many functions.	Second one without much functions and it’s monotonous. (P33)
Do not like play games (8,18.18%)	Participants do not like play games	I personally don't like playing games, so I am not interested in the second one. (This) is basically useless to me. (P40)
Do not like animals (6, 13.64%)	Participants do not like animals.	I don't like it, because I don't like little animals. (P29)
Functions are replaceable (4, 9.09%)	The functions of robots can be replaced by other technological products that users already have. For example, smartphones can replace some of the	Some functions can be replaced by smartphones. (P43)

	functions of robots.	
Machine-like (2, 4.55%)	Robots look like cold and emotionless machine.	It looks like a machine rather than a partner at home. (P35)
Hardware limitations (screen size) (1, 2.27%)	The hardware limitations cannot meet users' needs, such as the older people's vision decline, but the robot's screen is not big enough.	First one, although this robot has a screen, I am older and have bad eyes, so I'm afraid I can't see clearly. (P35)

5.4 Discussion

This study investigated older Chinese people's attitudes toward three different robot types to understand their preferences and attitudes for these robot types. RQ1 investigated older Chinese people's attitudes toward the three robot types (companion pet robots, task-oriented table robots, task-oriented movement robots). The current investigation found that older Chinese people hold different attitudes toward the different robot types: they hold positive attitudes toward task-oriented table and task-oriented movement robots, while they hold more varied attitudes toward companion pet robots. The results of comparing older people's attitudes toward different robot types has yet to be described in the previous literature.

In terms of their attitudes toward companion pet robots, this finding is consistent with that of Huang and Huang (2020) who found older Chinese people held varied attitudes toward companion pet robots. But the difference between Huang and Huang's (2020) study and this study is why older Chinese people hold varied attitudes. In Huang and Huang's (2020) study, older people who were living with family members and had experience with technology products, who were well educated and had medical profession backgrounds (a strange quirk of their sample), had more positive attitudes toward companion pet robots, while older people without experience of technology products, with only primary school education, tended to have negative attitudes towards companion pet robots. But in the current study, age is probably the reason which predicted whether participants would have varied attitudes: young older Chinese people held positive attitudes, while older Chinese people tended to have negative attitudes. This finding is contrary to previous studies (McGlynn et al., 2017; Van Orden et al., 2022) which suggested that older people hold positive attitudes toward companion pet robots. There are several possible explanations for the difference between the results of this study and previous studies. Firstly, those studies were conducted in the USA with older American people; thus, different cultural context may be the reasons for different attitudes toward companion pet robots. Secondly, participants in those studies interacted with robots, while participants in my study did not interact with the robots, but watched videos of a range of robots. Thus, I would conduct further research comparing actual interaction with robots and watching videos of them to investigate how this affects the measurement of older Chinese people's attitudes toward companion pet robots.

Regarding their attitudes toward task-oriented table robots, this study found that older Chinese people held positive attitudes regardless of age group. A possible explanation for this might be many older Chinese people in the study mentioned that they already use such robots in their daily lives, for example Xiaodu Smart Speaker[23] and Xiaomi Smart Speaker[24]. In addition, many participants said that even if they did not use this type of robot, they saw their children or friends use such robots. Thus, most participants had a good understanding and familiarity with this type of robot. Another possible explanation for this is that older Chinese people felt that this type of robot is practical and useful for them. According to these findings, we can suggest that older Chinese people accept task-oriented table robots and hold positive attitudes toward them. This finding is consistent with that of Chung et al. (2021) who found that older American people hold positive attitudes toward the smart speakers, and they were particularly fond of the smart speaker's ability to identify dangerous situations and alert someone to provide prompt assistance. However, the outcome of the current study is contrary to that of Thunberg et al. (2022) who found older people hold negative attitudes toward the Furhat robot (a blended embodiment of a physical robot head with a virtual face). A possible explanation for this is that the embodiment robot that was shown in the current study is iCat

[23] from Baidu, Inc., which is a Chinese multinational technology company specializing in Internet-related services, products, and artificial intelligence

[24] from Xiaomi Inc., which is a Chinese designer and manufacturer of consumer electronics and related software, home appliances, and household Hardware.

(an animal-like robot), which is probably more acceptable to older people. But the embodiment robot used in Thunberg et al. (2022) study is a human-like robot. The evidence from Study 2 (Chapter 4, Section 4.3.4) could also provide the explanation for why older people hold negative attitudes toward human-like robots; older people have concerns about humanoid robots; they do not want to robots which are too much like real humans, this might trigger the uncanny valley phenomenon (Mori et al., 2012).

In terms to older Chinese people's attitudes toward task-oriented movement robots, this study showed that older Chinese people hold positive attitudes toward this robot type regardless of age group. A possible explanation for this is that participants felt that the functions of this robot type seem more comprehensive. In addition, the participants also emphasized the healthcare functions of this robot type; they expressed their approval and believed that these functions are very useful and practical for older people when they watched the video that showed the robot assisting older people in caring for their health. This study supports evidence from previous studies (Bedaf et al., 2018; Ng's., 2012; Smarr et al., 2014), which showed older people hold positive attitudes toward task-oriented movement robots and willing to use it to assist them in daily life.

RQ2 investigated which type of robot (companion pet robots, task-oriented table robots, task-oriented movement robots) older Chinese people preferred more, and which kind of particular robot in each robot type they would prefer. The study found that older Chinese people prefer task-oriented movement robots the most, followed by task-oriented table robots and companion pet robots, when not considering age difference of the participants. This result does not appear to have been previously described, as no previous study could be found which compares which type of robot older people prefer. Only one study investigated older participants' preference for robot type with older British people. Samaddar and Petrie (2020) found that older British people had no specific preference for robot type and appearance when comparing to their preferences between pet robots and humanoid robots. A possible explanation for this might be older British participants in the study only saw images of the two different robot types, while older Chinese participants in this study watched videos, which would give them more understanding of the robot types. One thing worth mentioning is that older Chinese people aged in their 70s and above really did not like companion pet robots; almost all of them chose companion pet robots as their least preferred robot type.

The reasons older Chinese people did not like companion pet robots is worth investigating in greater detail in the future, and this is worth noting when developing robots for older Chinese people in the future.

One interesting finding is that compared with the number of participants who held positive attitudes toward task-oriented movement robots, a larger number of participants held positive attitudes toward task-oriented table robots; but their most preferred robot type is task-oriented movement robots, rather than task-oriented table robots. There are several possible explanations for this result. Task-oriented table robots have been popularized in China; the majority of older Chinese people in the study had either used them or seen their children and friends use them. In addition, this type of robot seems affordable for them, and its size is appropriate, which meets participants' expectations of robots. On the other hand, although older Chinese people think that task-oriented movement robots have more comprehensive functions and are more preferred, the price of this robot type seems to be more expensive. In addition, its size is large which requires ample home space to use it, but many older Chinese people's home space is not big enough to use such robot. Therefore, older Chinese people prefer task-oriented movement robots most, but their conditions may not allow them to use such robots in daily life. Thus, these findings cautiously suggest that task-oriented table robots are more acceptable than movement robots by older Chinese people.

In terms of older Chinese people's preferences for companion pet robots, participants most preferred companion pet robot is Aibo. This result is in agreement with Leong et al. (2016) which co-designed companion robots with older people. The final robot they co-designed was a companion robot in the form of a dog. In addition, the current study found that the participants preferred companion pet robots that can move and are highly interactive rather than robots that cannot move and are less interactive, and they do not like robot with furry appearance, such as Paro. This outcome is contrary to that of Bradwell et al. (2019) who found older British people preferred companion pet robots that were familiar and realistic, with a soft and furry appearance, and Lazar et al. (2016) who found older American people prefer companion pet robots with soft fur was conducive to petting. A possible explanation for this might be the different cultural backgrounds of the participants between the current study and previous studies (Bradwell et al., 2019; Lazar et al., 2016), which participants in the current study are from eastern countries while the participants in previous studies are from western countries. Thus, this different opinion about pet robots is worth further investigation to be sure.

Regarding the older Chinese people’s preference for task-oriented table robots, the majority of participants preferred Nanguo most. The study found that they preferred this robot type because it could have more practical functions and assist them in their daily lives, rather than have no practical functions and look like toys. This finding is consistent with that of Trajkova and Martin-Hammond (2020) who investigated the reasons older people become non-users of Intelligent voice assistants (IVA). They found that older American people thought Alexa (IVA) is a toy, and had difficulty finding valuable uses for it; beliefs associated with lack of ability of the IVA caused older people to become non-users.

In terms of older Chinese people's preference for task-oriented movement robots, Pepper is the Chinese older people's most preferred task-oriented movement robot, especially in older people aged 70 and above group. This is because they feel that Pepper is more like a real person, which can not only companion them but also assist in daily life. In addition, they thought Pepper's functions were more comprehensive than others; and it has hands, which could help them to pick up objects. These results are in agreement with the findings of Bedaf et al. (2018) who showed older Dutch people want robots to perform more intricate tasks akin to human caregiving.

RQ3 explored older Chinese people’s expectations about personal robots in general, and the three robot types in particular (companion pet robots, task-oriented table robots, task-oriented movement robots). In terms of their expectations of companion pet robots, the study found that although the participants hope that companion pet robots could have more practical functions, the main expectation of the participants is that the companion pet robots could look like real animals, that they could “Provide companionship”, and have more “Companion-Oriented Functionality”. These results are consistent with those of Lazar et al. (2016) who found that older American people want comfort and companionship from a robotic pet; they want robotic pets that can offer social amusement and enable chances for social engagement rather than reducing feelings of loneliness and social isolation by interacting only with the robots; and provide functional assistance. These results are also in agreement with Guerra et al. (2022) who reviewed the previous literature and found that older people expected that robots to be like real pets and perform multiple functions. In addition, one unanticipated result was that participants wanted companion pet robots that could provide "Communication", although the robot videos did not show that companion pet robots could communicate with people. A possible explanation for this might be participants expected this robot type could "Provide companionship", and "Communication" as an important aspect of the "Companion-Oriented Functionality", which could achieve this purpose.

Regarding the older Chinese people's expectations of the task-oriented table and movement robots, the study found that participants have more expectations of these two robot types than companion pet robots; their expectations cover all aspects related to functionality. At the same time, participants have different expectations between these two types of robots. In terms of task-oriented table robots, participants highlighted the theme of “Usability”, and all aspects related to “functionality”, but they did not mention anything that related to the appearance of this robot type. From this, I cautiously suggest that the functionality of the task-oriented table robot is far more important than its appearance in older Chinese people’s perceptions. This finding was also reported by Frennert et al. (2012), older Swedish people thought a robot's functionality was more important than its appearance. In addition, although participants want this type of robot to have much more functions and be useful, they want this robot type to be simple in both interaction and functions. Participants emphasized the theme of “Interaction method”, especially with the sub-themes of “Voice interaction” and “Speak Chinese”. These results reflect those of Samaddar and Petrie (2022) who found that older people express enthusiasm for incorporating voice-controlled robots into their daily routines. This finding is also consistent with that of Biswas et al. (2020) who found that older British people showed a stronger preference for speech-based interaction with robots over tablet-based interaction. In addition, the particular functions that participants emphasised were the sub-theme of “Voice interaction”, which is used in “Contacting others”, “Information access”, and “Reminding”. For example, participants expected that robots to answer their questions, to facilitate them getting information, and to remind them of their daily schedule by voice. This could also explain why participants highlight the “interaction method” when commenting on this robot type.

In terms of the task-oriented movement robots, as I expected, the participants wanted the robots to take care of them like caregivers, to companion them and assist them in their daily lives. This finding was also reported by Bedaf et al. (2018) who found that older Dutch people want robots to perform more intricate tasks; and be able to perform complex tasks tailored to the user's preferences, which would necessitate the robot being highly adaptable and intelligent, akin to human caregiving. Another important finding is that participants highlight the theme of “Healthcare-Oriented Functionality”, especially with the sub-themes of “Health Alarm”, “Health monitoring”, and “Fall detection”. A possible explanation for this might be the task-oriented movement robot video showed material that related to “Healthcare-Oriented Functionality”, and this was approved of by the participants. Although the fact that participants highlighted this aspect of task-oriented movement robots might be influenced by the video, they indicated that these functions are very important for older people. However, one unanticipated result was that participants did not highlight the “interaction method” as I expected since this robot type could interact with people in different ways, such as touch and voice, and this robot could move and have many sensors. A possible explanation for this might be that practical functions are most important for participants in relation to this robot type, such as “Healthcare-Oriented Functionality”; thus, they did not think to mention “Interaction method” spontaneously.

In terms of older Chinese people's expectations for robots in general, the most interesting finding is that participants' expectations of robots are similar to their expectations of the task-oriented movement robots. And what is surprising is that participants want robots with "Human-like behaviour and appearance", while no participants mentioned that they expected that robots with “Animal-like appearance/behaviour”. This could also explain their preference for robot type, in that they preferred task-oriented movement robots most, and companion pet robots as their third preference. In addition, not only did participants want robots with "Human-like behaviour and appearance", they even gave negative comments on "machine"; participants do not like the robots, but might look like cold and emotionless machines. These results are in agreement with recent studies indicating that older Swiss people have less sense of uncanniness and a greater inclination to use both human-like and android robots based on their appearances (Lehmann et al., 2020). However, his outcome is contrary to that of Frennert et al. (2013) who found older Swedish people want the robots as a machine but not as a friend. A possible explanation for this might be that Frennert's study was published a decade ago; thus, the views of older people in that study may not be the same as those of older people today. Another possible explanation for this is that participants in Frennert's study were asked to imagine the potential role of robots by themselves and were not shown any pictures or videos of robots; thus, participants may only have an impression of robots from their previous experience of robots, which may have been slight. The results from this study were also different from Samaddar and Petrie’s (2020) study mentioned earlier; they found that older British people do not have a preference for the robot appearance, no matter whether pet or humanoid robots. In addition, the results from this study are also different from Study 2 (Chapter 4, section 4.3.4), which found that older Chinese have concerns about "Humanoid" robots; participants in Study 2 did not want robots that are too much like real humans. A possible explanation for this might be that participants in Study 2 were not shown any pictures or videos of robots; they were provided with information about robots from my oral introduction. Thus, the participants did not see a concrete images of robots in Study 2; they expressed opinions about the robot mainly based on their imagination, even though I had introduced some information about robots to them. Another possible explanation for this is that Liu et al. (2021) found that Older Chinese people perceived small, animal-like robots as having high warmth, whereas they perceived android and steel-made machine-like robots as having high competence. This matched the fact that participants highlight that they want robots to have more practical functions.

RQ4 investigated older Chinese people’s concerns about using personal robots in general. The study found that older Chinese people have concerns about robots being “Affordable” and “Too difficult to use”. These results reinforce those of Frennert and Östlund (2020). who also found that older Swedish people had the same concerns about using robots. In addition, compared to Study 2, in which participants expressed six different concerns, the concerns that emerged in this study are far fewer, although this might be because the interviews did not include any specific questions about concerns, while there were specific questions about concerns in Study 2. Thus, this might cause people not to raise many concerns in the current study. Another possible explanation for this might be after watching the videos, the participants had a more comprehensive understanding and a concrete image of robots, which dispelled some of their concerns. However, although participants do not have many concerns about the robots, they did give many negative comments about the robots when watching the videos. Many negative comments agreed with previous research, especially on the usefulness aspect. For example, many participants in the study mentioned “Useless”, which is in agreement with Trajkova and Martin-Hammond (2020) findings which showed the reason older American people have transitioned from being users of robots to non-users is that difficulty finding valuable uses for them. One interesting finding is the theme of “Immobile”, which was mentioned most frequently by participants. Participants do not prefer the robots which cannot move, but they show positive attitudes toward task-oriented table robots compared to other robot types. This also shows the contradictions and complexity of the attitudes of older people. As mentioned above, although participants prefer task-oriented movement robots more, they are more likely to use task-oriented table robots in their lives. Because task-oriented table robots are functional without taking up much space, and the price may also be affordable, even though the task-oriented table robots cannot move.

One interesting point is no participants in this study mentioned the themes of “Privacy and security” or “Deception”, which was highlighted by older Chinese participants in Study 2. Sharkey and Sharkey (2012) in discussing the six key considerations that should be taken into account prior to the full deployment of robot technology in the care of older people, includes breach of privacy and the potential for deception and infantilization, as well as potential decrease in human interaction, an elevation in feelings of objectification, loss of autonomy, curtailment of personal freedom, and the circumstances under which older people should have control over robots. In addition, a study was conducted in the UK, France and the Netherlands with potential robot users (older people, informal carers, formal carers), found that all groups emphasized that privacy should be protected, and the notion that robots are incapable of, and should not attempt to replace human interaction (Draper., 2014). Older Chinese participants in this study had no concerns about the themes of “Privacy and security” and “Deception” after watching videos about robots and having a deeper understanding and whole picture of robots that could help older people in their daily lives. A possible explanation for this might be the older Chinese participants in Study 2 did not watch videos about robots and therefore lacked knowledge about robots used in daily life. One participant noted that they were influenced by some movies about robots and believed that robots were advanced intelligent and high-tech; thus, they thought robots might deceive humans. Although participants in this study did not spontaneously mention these two themes, this does not mean that they did not have any concerns about them, if they had been directly asked, they may have volunteered information on these themes.

Taken together, according to these findings, I can suggest that older Chinses people expected robots should have a humanoid appearance, be anthropomorphic, and have human-like behaviour rather than simply functioning like a machine. From older Chinese people's perspective, robots should be like caregivers, being a companion and taking care of every aspect of their lives, looking after their health, and serving as guardians of their home security. Robots should be mobile and highly interactive; they do not like robots that cannot move or interact with them. In addition, robots should have as many practical functions as possible; older Chinese people do not like robots that are all style and have no substance.

The study used qualitative methods to assess older Chinese people’s attitudes and preferences toward the different robot types and explore their expectations about the robots. Participants in the study watched videos of different types of robots, which helped them to have an understanding of robots and then explored their attitudes towards them. This research method is different that used in Study 2 (Chapter 4), which investigated older Chinese people's attitudes toward the robot without showing videos to introduce the idea of robots. This difference is worth further research, in both research methodology and whether older people's attitudes toward robots are influenced by their previous level of their understanding of robots. However, the study did not use any quantitative methods, which could provide more objective results and complement the qualitative data. Another limitation of this study is that all participants live in an urban area of China and probably had a good experience with technology. Further work is needed to understand the attitudes toward robots of older Chinese people who live in rural areas and with different levels of experience with technology.

5.5 Conclusions and future work

The purpose of the current study was to assess older Chinese people’s attitudes and preferences for companion pet robots, task-oriented table robots, and task-oriented movement robots. This study has established that older Chinese people hold positive attitudes toward task-oriented table robots and task-oriented movement robots. However, they hold varied attitudes toward companion pet robots, in that some participants hold positive attitudes toward this robot type, while some participants hold negative attitudes. Older

Chinese people with positive attitudes toward companion pet robots are mainly those aged between 60 and 70. The second major finding was that older Chinese people preferred task-oriented movement robots most, no matter which age group; but older Chinese people aged 70 and above do not like companion pet robots. Finally, the study found that although older Chinese people have different expectations for different types of robots, for example, they expected that companion pet robots could "Provide companionship" and with "Animal-like appearance/behaviour", while they expected task-oriented robots could "Speak Chinese" and have much more "Task-oriented functionality." But when considering robots in general, they expect robots to have a "Human-like appearance and behavior", and they want the robot to be a companion and assist them in daily life like a caregiver.

Notwithstanding the study has limitations that were discussed mentioned, the study confirmed that older Chinese people hold positive attitudes and are willing to use robots, which shows that it is feasible to use robots to care for and to be a companion for older people and provides suggestions for solving the care of older people problem in the future. In addition, the study contributes to our understanding of the attitudes and preference of older Chinese people towards different robot types and helps us to understand older Chinese people's expectation of robots. This study also found that there have differences in the attitudes and preferences about robots by older people in different age groups, which also provides new ideas for future research, and attention should be paid to this point when designing robots for older people in the future.

Due to the fast pace at which China's aging population is expanding, there is an immediate need to address the issue of care of older people in present-day Chinese society. This has led to significant attention from both the government and the broader community[25]. The use of technology to support and provide care for older people has been identified as a possible resolution to the issue[26][27]. Robots with "Human-like appearance and behavior", which could provide companionship and assist older people in daily life like a caregiver, would be more popular among older Chinese people. But there are also issues of affordable and privacy to consider when developing such robots for older Chinese people.

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[25] URL: https://www.ndrc.gov.cn/fggz/fgjh/yxyd/202012/t20201227_1260455.html

[26] URL: https://www.mca.gov.cn/article/xw/mtbd/202101/20210100131839.shtml

[27] URL: http://www.npc.gov.cn/npc/c30834/202203/813d4151d21941ffb4c130f0c5817606.shtml

Chapter 6: Study 4: MiRo - Attitudes and expectations of a pet robot for older Chinese people for companionship and assistance

6.1 Introduction

Study 3 investigated older Chinese people’s attitudes toward different robot types (companion pet robots, task-oriented table robots, and task-oriented movement robots). The results from Study 3 showed that older Chinese people hold significantly different attitudes toward these three robot types. While they hold positive attitudes toward the task-oriented table and movement robots, they hold varied attitudes toward companion pet robots: participants who aged in 60s hold positive attitudes, while participants who aged at 70 and above hold negative attitudes toward companion robots. In addition, as mentioned in the literature review (Chapter 2), there is limited research on attitudes toward companion pet robots by healthy older people who live outside institutional settings; the existing studies on pet robots for older people have focused on therapeutic situations, such as for people with dementia, and has been conducted in nursing homes or hospitals rather than for older people living independently.

Thus, a pet robot was chosen in the next study to further explore older Chinese people’s attitudes toward this robot type in order to further understand why older Chinese people hold varied attitudes toward companion robots. This study also investigated the attitudes of older Chinese people to companion pet robots in general, both as companions and assistants, and explored their expectations about using companion pet robots in these roles. Therefore, the objective of this study was to investigate the attitudes of older Chinese people toward the MiRo pet robot (Figure 1, https://www.miro-e.com/), and aimed to understand older Chinese people's attitudes and expectations of the MiRo robot in both companion and assistance aspects.

The Almere model questionnaire (see Chapter 2, section 2.8.1) was used in the study to investigate older Chinese people's attitudes toward the MiRo robot. The Almere model not only considers factors such as “Perceived usefulness” and perceived ease of use but also incorporates variables related to social interaction when explaining the intention to use robots. As discussed in Chapter 2, the model was evaluated through a combination of controlled experiments and longitudinal data collection involving three distinct robots deployed in care facilities for older people and older people's own homes. In addition, as I mentioned in Chapter 2, the Almere model was validated by measuring older people's actual use of robots, in which the researcher left robots in the public area in the care facilities for older people for one week, to see whether they would use or interact with robots. Results strongly supported the Almere model, explaining between 59% to 79% of the variance in usage intentions and between 49% to 59% of the variance in actual use (Heerink et al., 2010). However, the Almere model constructs were originally theoretically largely derived from the TAM and UTAUT model and not directly evidence-based with older people, although the relationship between constructs was validated by three controlled experiments as I mentioned above. In addition, there are lots of little constructs in the Almere model, and statement on different construct may seems similar particular for older people, but actually, if people have a positive on one and have a positive on another; for example, participants in this study mentioned that the statements are similar in Anxiety construct when they filled out the questionnaire, the statement of "If I should use the robot, I would be afraid to make mistakes with it" is similar with the statement of "If I should use the robot, I would be afraid to make mistakes with it". Thus, for the users, it is not a particular distinct thing, and it might be a waste of time to measure. Moreover, some constructs were taken straight from TAM and UTAUT without validation of whether they were appropriate. In addition, as mentioned in the literature review (see Chapter 2.8.3), the robots used in Heerink's study are assistive social agents rather than pet robots, and the participants in his study are from the Netherlands. Thus, another aim in the current study is to explore whether the Almere model useful in understanding older Chinese people's attitudes toward the MiRo robot, and whether there is a smaller number of underlying constructs that would account for older Chinese people's attitudes to MiRo robot.

The study investigated the following research questions:

RQ1: what kind of animal do older Chinese people think MiRo is and what the gender do they think it is?

RQ2: What are older Chinese people's general attitudes about the MiRo pet robot and what kind of support do they think it should provide?

RQ3: What are older Chinese people's attitudes and expectations of the MiRo robot as a companion?

RQ4: What are older Chinese people's attitudes and expectations of the MiRo robot as an assistant to perform tasks for them?

RQ5: Is the Almere model useful in understanding older Chinese people's attitudes toward the MiRo robot?

RQ6: Is there a more concise model compared to the Almere mode?

6.2 Method

6.2.1 Design

The study was conducted in person in China to investigated older Chinese people's attitudes toward a pet robot, MiRo, to understand older Chinese people's attitudes and expectations of pet robots, their preference for the type of pet robot, and what they want from them. The study used semi-structured individual interviews and group interviews. This was for both practical and methodological reasons. Recruiting enough older people was a challenge in the immediate post-COVID period, so accumulating enough participants for individual interviews was not possible. In addition, conducting the interview, which consisted of a number of sections, was not possible to get enough people for one-to-one interviews since China was still in a semi-lockdown state during the period when the research was conducted. Rather than doing a group interviews, older Chinese people would find it difficult; they are polite and don't want to say their opinions. Thus, the study was conducted in semi-structured individual and group interviews.

Both the interviews and group interviews were divided five sections. In the first section, I demonstrated the MiRo pet robot, showing how to interact with it. Participants then interacted with MiRo themselves. In the second section, participants watched a video comprising several different clips illustrating the current and potential capabilities of MiRo. In the third section, participants were either interviewed individually (or sometimes with their partner) or participated in a group interviews discussion about their opinions of MiRo, of pet robots in general, and what they want from them. In the fourth section, participants completed the Almere Model Questionnaire in relation to the MiRo robot. The final section collected participants' demographic information.

6.2.2 Participants

The inclusion criteria for participants are the same as in previous studies in this programme of research: the participants needed to be 60 years or older and retired (see Chapter3, section 3.2.1).

Opportunistic and snowball sampling were used for participant recruitment. Group interviews' participants were recruited through my personal contacts and by publicity through a facility which includes a nursing home and independent but supported living apartments (i.e. opportunistic sampling) in Hefei, a city of approximately 10 million people, in the Province of Anhui in China. Individual interview participants were also recruited through my personal contacts and snowball sampling, asking the initial participants if they would like to participate in the study (i.e. opportunistic sampling). Then through these participants, I asked them if they knew anyone else who met the criteria and would like to participate (i.e. snowball sampling). Potential participants were contacted through the WeChat message service and asked if they would participate in the study.

65 participants took part in the study, ranging from 60 to 93 years old, with an average age of average age is 70.4 years. 39 were women and 26 were men, Table 6.1 shows the age distribution of the participants. All participants were living independently in the community, usually with a partner and often other family members. They come from a wide range of educational and economic backgrounds, typical of urban China. Nevertheless, with this population of Chinese people, it is not appropriate to ask them about their specific educational background and occupation; thus, the study only collected basic demographic information of participants, such as gender and age. 32 people participated in 7 group interviews (see Table 6.2). 33 participated in the interviews, 8 were interviewed by themselves, and 25 were interviewed with another family member or friend.

Table 6.2 shows the age and gender distribution of the participants in each group interviews.

Table 6.1: The age and gender distribution of the participants

Age groups	Male	Female	Total
60-69	21	18	39
70-79	1	6	7
80 above	4	15	19
Total	26	39	65

Table 6.2: The age and gender distribution of the participants in each group interview

	Age groups		
	60-69	**70-79**	**80 above**
Group interviews 1 (N=3)			
Male	3	-	-
Female	-	-	-
Group interviews 2 (N=4)			
Male	-	-	1
Female	1	2	-
Group interviews 3 (N=6)			
Male	2	1	-
Female	2	1	-
Group interviews 4 (N=4)			
Male	1	-	-

Female	-	1	2
Group interviews 5 (N=3)			
Male	-	-	1
Female	-	2	-
Group interviews 6 (N=7)			
Male	-	--	
Female	-	1	6
Group interviews 7 (N=5)			
Male	-	-	-
Female	5	-	-

6.2.3 Apparatus and materials

The pet robot used in the study is a MiRo (Figure 6.1), which is an animal-like robot, approximately 40 cm tall, with six sensors and eight degrees of freedom and a "biomimetic" control system (meaning it is a machine that mimics biological features) that can interact with people and appears to express emotions such as happiness and annoyance. Its shape incorporates features of various animals, such as cat-like eyes and rabbit-like ears, and it has a circadian rhythm like real animals and needs to "sleep". It can move autonomously, its head, eyes and ears all move to create expressions and it reacts in a pet like way to human interaction, for example it can nudge a human in response to being petted and turns towards a human voice (Collins et al., 2015; Prescott et al., 2017).

Although various pet robots are available on the market, such as Paro (a pet robot seal, see Chapter 2.7), which has been the most commonly used robot in research about pet robots and older people, MiRo is the most suitable for this research for a number of reasons. Firstly, MiRo combines the characteristics of many animals; thus, it does not have a specific animal image, which helped me explore which type of animal older Chinese people would prefer as a pet robot. Secondly, MiRo is biomimetic, making it like a real animal, with apparent emotions and circadian rhythms, and has robust interactivity, which means it can appear to express emotions and react to people. Thirdly, MiRo has the potential to perform many practical functions to assist older people. For example, MiRo has a camera and the ability to move; thus, MiRo can quickly locate older people and assess the situation if older people experience an emergency at home. Therefore, MiRo is a pet robot that combines both companionship and assistance features, which aligns with the aims of the study to explore older Chinese people's attitudes toward pet robots as both companions and assist in daily life.

Figure 6.1: MiRo pet robot [Source: miro-e.com]

A pet robot MiRo can be programmed, which can add functions in addition to those initially provided. Thus, many institutions use MiRo for research and add many different functions to MiRo. I selected a range of publicly available videos to show MiRo's potential functions that other researchers have programmed. Three short videos were chosen from YouTube to show functions that could not be demonstrated with the MiRo in the study, but which MiRo has the potential to achieve. This was also a backup in case of technical failure of MiRo during a demonstration, which fortunately never happened. More importantly, the videos gave participants a more comprehensive understanding of the potential of the MiRo robot.

In the first video, Miro monitors the health of older people: it detects if an older person falls down at home, MiRo finds them and can call for assistance. This video was produced by the Heriot-Watt University HRI lab (Figure 6.2). The second video was produced by the Brainary (an educational, robotics and assistive technology resource supplier), which shows MiRo's communication function, in which older people chat with MiRo (Figure 6.3). MiRo's companion potential was shown in the third video, a woman tells a story to MiRo, and then MiRo reactions on an appropriate emotional manner. This video was produced by the City of Canada Bay Libraries (Figure 6.4). All three videos are in English with Chinese subtitles, each video is around 30 seconds.

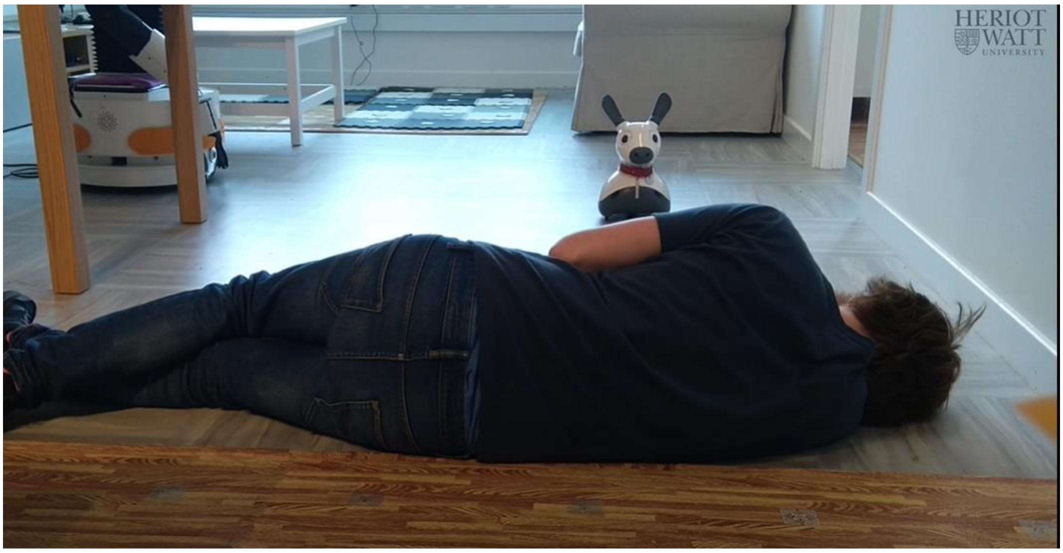

Figure 6.2: MiRo pet robot fall detection [Source: https://www.youtube.com/watch?v=72ruYQai-ww]

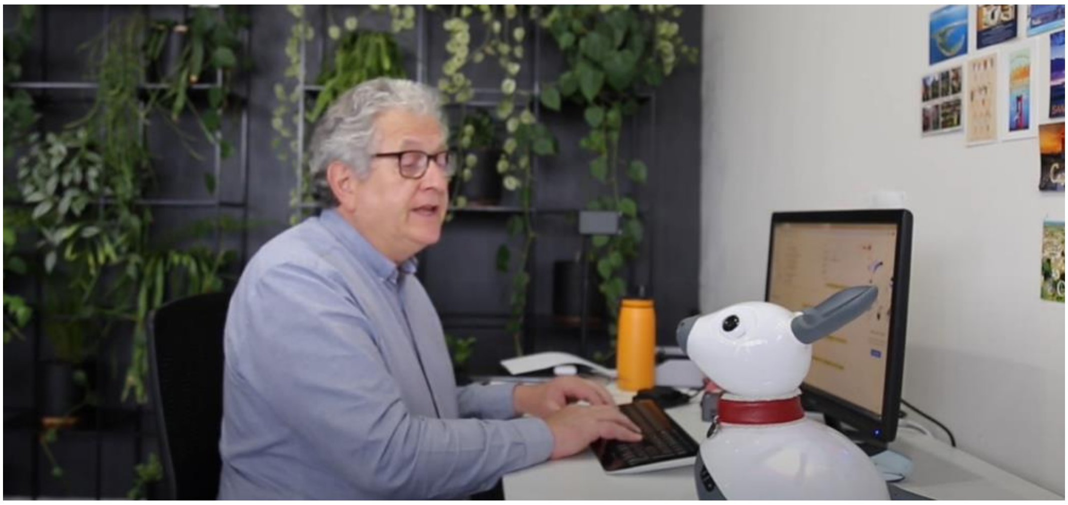

Figure 6.3: MiRo pet robot communicate with older people [Source: https://www.youtube.com/watch?v=exr-xGP_o5E]

Figure 6.4: Storytelling with MiRo [Source: https://www.youtube.com/watch?v=z8XYvOl8vxY&t=476s]

The Almere Model questionnaire (see Chapter 2, section 2.8.3) was used to explore older Chinese people's attitudes toward the MiRo robot. The questionnaire items (see Table 6.3) were adapted in my research to fit the context of pet robots by rephrasing some items. For example, in the item of Perceived Sociability, the original question is "I consider the robot a pleasant conversational partner", we removed "conversational" because MiRo cannot communicate with participants in the study; and in the item of "Social presence" I changed "person" to "pets." In addition, MiRo does not have the advice-giving capability; thus, I removed the Trust section from the questionnaire, but I interviewed participants about their attitudes and expectations toward pet robots, which included communication and trust topic.

The original Almere Model questionnaire continued 12 items, the questionnaire that was used in the study contained 11 items (see Table 6.3, see Appendix H.) for a comparison with the original questionnaire items. The participants answered these statements using 5-point Likert scales (1 = totally agree, 2 = agree, 3 = don't know, 4 = do not agree, 5 = totally do not agree). The questionnaire was translated into Chinese by two Chinese postgraduate students proficient in English and Chinese.

All interviews were recorded using iPad voice record system for later analysis, and some interviews were also recorded using GoPro (action cameras) if participants were allowed to have video recorded. All three videos were played on a laptop in the interviews and group interviews. Participants completed the Almere model questionnaire on the paper.

Table 6.3: The Almere Model Questionnaire as adapted for this study

Construct	Questions / items
Anxiety (ANX)	If I should use the robot, I would be afraid to make mistakes with it
	If I should use the robot, I would be afraid to break something
	I find the robot scary
	I find the robot intimidating
Attitude towards technology (ATT)	I think it's a good idea to use the robot
	The robot would make life more interesting
	It's good to make use of the robot
Facilitating conditions (FC)	I have everything I need to use the robot
	I know enough of the robot to make good use of it
Intention to Use (ITU)	I think I'll use the robot during the next few days
	I'm certain to use the robot during the next few days
	I plan to use the robot during the next few days
Perceived adaptiveness (PAD)	I think the robot can be adaptive to what I need
	I think the robot will only do what I need at that particular moment

	I think the robot will help me when I consider it to be necessary
Perceived Enjoyment (PENJ)	I enjoy the robot talking to me
	I enjoy doing things with the robot
	I find the robot enjoyable
	I find the robot fascinating
	I find the robot boring
Perceived Ease of Use (PEOU)	I think I will know quickly how to use the robot
	I find the robot easy to use
	I think I can use the robot without any help
	I think I can use the robot when there is someone around to help me
	I think I can use the robot when I have a good manual
Perceived Sociability (PS)	I consider the robot a pleasant partner
	I find the robot pleasant to interact with
	I feel the robot understands me
	I think the robot is nice
Perceived Usefulness (PU)	I think the robot is useful to me
	It would be convenient for me to have the robot
	I think the robot can help me with many things
Social Influence (SI)	I think the others would like me using the robot

	I think it would give a good impression if I should use the robot
Social Presence (SP)	When interacting with the robot I felt like I'm talking to a real pet
	It sometimes felt as if the robot was really looking at me
	I can imagine the robot to be a living creature
	I often think the robot is not a real pet
	Sometimes the robot seems to have real feelings

6.2.4 Demonstration and Interview schedule

The demonstration of MiRo, individual and group interviews followed the same process.

Before the main interview section, I introduced myself and why I were doing the project, got participants' verbal consent, which showed they were willing to participate in the study.

The first section of the main interview schedule is the demonstration section. I presented the companion pet robot MiRo to participants with a brief introduction about MiRo and its functions. Then, I showed how to interact with MiRo using three tasks:

(1) I put MiRo on the table, then petted it, and it reacted to me. MiRo would half-close its eyes and put his head down, apparently enjoying my touch.

(2) still with MiRo on the table, it reacted to a MiRocube (see Figure 6.5). I held up the MiRocube, and MiRo was apparently attracted by the MiRocube and came to the MiRocube.

(3) I put MiRo on the floor and had it do something in which it moves. I place MiRo far away, then call MiRo's name and clap my hands; MiRo will come to me.

This demonstration took approximately 5 minutes.

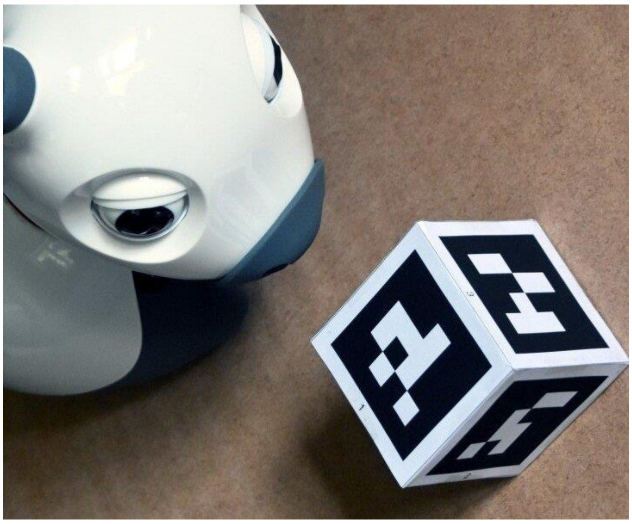

Figure 6.5: MiRo with MiRocube [Source: miro-e.com]

Then, the second section of the main interview schedule is the interaction section. Participants were asked to interact with MiRo with the same tasks. Each interview participant interacted with MiRo around 5 minutes. Participants in the groups interview spent around 10 minutes interacting with MiRo. They can interact with MiRo alone, or interact with MiRo with other participants.

After that, to help participants get the whole picture of MiRo, they watched videos that gave more information about MiRo, especially the functions of MiRo which had not been demonstrated live, such as fall detection and communication. Although the videos have Chinese subtitles, all three videos are in English; so, I introduced the content of the videos to the participants. Participants also had the opportunity to ask questions at any time if they did not fully understand what was shown in the video. Participants spent approximately 5 minutes watching videos.

The third section of the main interview schedule is the interview section. Firstly, I investigated the participants' initial impressions of MiRo, such as what kind of animal MiRo is and MiRo's gender. Then, I explored their expectations and attitudes toward MiRo, for example, what they want MiRo to do with them and whether they have any concerns about using MiRo at home. I gave some prompts to the participants to try to draw more ideas from the participants because the functions of MiRo shown in the video are still limited; thus, I hope that the participants can have more imagination about MiRo instead of being limited in the function shown in the video. A range of prompts was mentioned, for example by asking them could MiRo help you with looking after your health, such as monitoring blood pressure?

In the fourth section, participants completed the Almere Model questionnaire on paper by themselves.

Participants' general demographic information was collected in the final section, such as their gender and age.

6.2.5 Pilot study

A pilot study was undertaken, in particular to assess the effectiveness of the interview schedule. The same two older Chinese people who conducted the pilot of Study 1, piloted the materials for this study. They pilot all sections, including demonstration, interaction, and interview. The whole process went smoothly, but when they talked about their expectations for companion pet robots, they did not have many ideas and I realized that I might need to prompt participants. Thus, prompts on both the companion and assistant aspects of what MiRo can do were developed and added to the interview schedule.

6.2.6 Procedure

The study received ethical approval from the Physical Sciences Ethics Committee of the University of York.

Individual interviews and group interviews are followed the same procedure: Firstly, the session started with building rapport, I introduced myself and why I was doing the project. Then, I gave brief introduction about the study, and what they would be asked to do. They had the chance to ask questions. Then, I read the consent form to them and asked them whether they would be willing to participate in the study; after that, they were asked to give verbal consent. Next, they were asked to give permission to audio or video record the interview, which was audio recorded using iPad voice records, and video recorded using GoPro (action cameras).

Participant data in the study was anonymous, and each participant was given a demographic questionnaire on paper that showed a code number (they were asked to complete the questionnaire at the end of the session and give it back to me). Participants could ask questions at any time or withdraw from the study, their data would be deleted using their code if they wanted to withdraw from the study.

Next, the main interview or group interviews started with the demonstration of MiRo section, I introduced and showed how to interact with the pet robot MiRo; then, participants interacted with MiRo themselves. Each participant in the interview interacted with MiRo alone for five minutes; some participants in the group interviews interacted with MiRo for a couple of minutes alone or interacted with MiRo with other participants. In a group interviews, every participant was given the chance to interact with MiRo, but some participants did not wish to interact with MiRo; thus, these participants were around other members of the same group and watched them interact with MiRo. Most participants in the interviews and group interviews followed the flow of the tasks I had demonstrated to interact with MiRo; however, some participants in the group interviews completed only one or two of the tasks or just watched other group members interact with MiRo. Firstly, they petted MiRo, then MiRo reacted to participants. Then, Participants use cubes to attract MiRo's attention. Next, participants called out to MiRo from a certain distance away to let MiRo come to them. During the interaction with MiRo, some participants also commented on MiRo; for example, one participant (P65) commented: "MiRo was cute and looked like my cats."

Then the participants in both interviews and group interviews watched the three short videos about MiRo on a laptop. Participants also asked some questions when they watched the videos; for instance, one participant (P8) asked the question when she was watching the video about communication function: “Could it answer me which hospital I should go to?”

Next, the semi-structured interview or group interviews discussion was conducted. After the interview or discussion, participants completed the questionnaire with the adapted Almere model (see Table 6.3) about the MiRo robot on paper by themselves (I had distributed this questionnaire with the demographic questionnaire at the beginning of the study). Finally, participants completed the demographic questionnaire and returned the questionnaires to me.

6.2.7 Data analysis

All interviews and group interviews were voice recorded. I carefully transcribed each recording in Chinese and translated it into English. Two analytical methods were used analyze the qualitative data in this study, content analysis (Schreier. 2012) and thematic analysis (Braun and Clarke, 2006). Analysis methods and steps of content analysis and thematic analyses were same with previous studies (see Chapter4, section 4.2.7).

Chi-square goodness of fit tests were used to analyze the categorical data, numbers of participants giving different preferences. Questions on the Almere Model questionnaire were ratings. These were not normally distributed, so non-parametric rather than parametric analysis was used. One sample Wilcoxon signed rank test was used to analyze these data. The PCA analysis was used to summarize the statements from the Almere model and reshape the Almere model.

6.3 Results

6.3.1 The characteristics of MiRo

RQ1 investigated what animal older Chinese people think MiRo is and what gender they think it is. Table 6.4 shows that the most commonly reported animals were a rabbit or dog. However, 13 (20.0%) of participants felt that MiRo contained the characteristics of many animals, so they could not determine which animal MiRo was. The majority of participants felt that MiRo is a girl (42, 64.62%), with only 17 (26.15%) participants felt that it is a boy and 6 participants were unsure of MiRo's gender, because they felt that MiRo looked like both a boy and a girl. A chi-square test showed that was a significant tendency to think MiRo is a girl (X^2 (2) = 31.42, $p < 0.001$).

Table 6.4: Animal which older Chinese participants think MiRo is

Animals	Rabbit	Dog	Mix/unsure	Deer	Sheep	Donkey	Mouse	Pig
N	24	21	13	2	2	1	1	1
%	36.92	32.31	20.0	3.08	3.08	1.54	1.54	1.54

6.3.2 Older Chinese people's attitudes and expectations about the MiRo robot

In relation to RQ2, older Chinese participants general attitudes and expectations about the MiRo robot, the participants overall expressed positive attitudes toward the MiRo 62 (95.38%) indicated that they would be happy to have MiRo in their home, while only two participants did not want to have MiRo. Because they don't need it and they want to go out rather than stay at home, but one of the participants mentioned if he was in poor health and could only stay at home, he would need MiRo to take care of him. A chi-square test showed this was a significant difference (χ^2 (1) = 52.25, $p < 0.001$).

Participants were asked whether they would want MiRo to be a companion or assistant (i.e. do tasks for them). 24 (36.92%) participants hoped that MiRo could do more task-oriented functions, 21 (32.31%) participants wanted MiRo to be a companion, and 16 (24.62%) participants wanted MiRo to serve both roles. A chi-square test showed no significant preference between roles ($\chi^2(2) = 1.61$, $p = 0.45$).

RQ3 investigated older Chinese people's attitude and expectations about the MiRo robot as a companion. Despite more participants mentioning that they want MiRo could do more task-oriented functions, the majority of participants (59, 90.77%) said "yes" when asked if they would like MiRo to be a companion, while only 6 (9.23 %) participants did not want MiRo to be a companion. A chi-square test showed this was a significant difference (χ^2 (1) = 43.22, $p < 0.001$). Similarly, those participants (59, 90.77%) who would like MiRo to be a companion also want to talk with MiRo; again, this was a significant difference (χ2 (1) = = 43.22, $p < 0.001$). In addition, 41 (63.08%) participants want to play with MiRo, while only 4 (6.15%) participants do not want to. A chi-square test showed this was a significant difference (χ2 (1) = 30.42, $p < 0.001$).

Thematic analysis was used to analyze participants' expectations of MiRo as a companion. Four broad themes emerged (see Table 6.5), which are "Entertainment", "Communication", "Outdoor companion" and "Exercise". In relation to "Entertainment", participants want to entertain themselves by playing with MiRo and tease it to make fun, like people teasing their cat. In relation to "Communication", many participants expressed their desire to be able to chat with MiRo, also to be able to ask MiRo questions, such as the about the weather (however, information and advice have been categorized under MiRo's ability to perform tasks, see below). There has an interesting theme worth mentioning that "Outdoor companion", they also wanted to be able to take Miro as an outdoor companion, taking out for a walk, as people walk their dogs. Finally, a participant often mentioned that they wanted MiRo to accompany them to exercise together

Table 6.5: Older Chinese participants' expectations of MiRo as a companion (N – number of participants mentioning, %)

Category	Definition	Example quotes
Entertainment (27, 41.54%)	Be able to entertain oneself with MiRo	I hope it can sing, dance, and entertain me. (P21)
Communication (22, 33.25%)	To be able to communicate with MiRo through voice.	It can communicate with older people who live alone, talk and accompany them, and understand what they say (P17)
Outdoor companion (7, 10.77%)	To be able to take Miro outdoors, so it is not just an indoors companion.	I can take it outside. For example, take it with me when I go for a walk, which is the best. (P21)
Exercise (1,1.54%)	To be able to do exercise with MiRo and have it guide the user	It could accompany me to doing exercise and play pin pong. (P14)

RQ4 investigated older Chinese people's attitudes and expectations about the MiRo robot to perform tasks. All participants (63, 96.92%) who responded to the task-related questions indicated that they would be willing to have MiRo help them look after their health and remind them to take medicine.

Thematic analysis was used to analyze participants' expectations of MiRo to perform tasks. Table 6.6 shows 10 themes or functions that were mentioned by participants.

During the interviews, the themes of "Reminding" were often mentioned. Participants often mentioned that their memory declines as they get older, so they wanted MiRo to provide reminders, such as reminding them to take their medicines and of important events. It is worth noting that the theme of "Monitor home safety", which was usually mentioned by participants. In relation to the theme of "Home security monitoring" participants hope that MiRo can monitor home safety, especially of gas leak problems. Many participants said that they had the experience of forgetting to turn the gas off, so monitoring this would be very helpful. In addition, participants highlighted health topics and wanted MiRo to help take care of their health, such as monitoring their blood pressure and detecting if they fall. Besides, the health topics and the theme of monitoring home safety were usually related to the "Reminding" theme, which was mentioned together by participants. Participants hoped that when the robot detected abnormalities or home security problems, it could remind them to pay attention.

Table 6.6: Older Chinese participants' expectations of MiRo to perform tasks (N – number of participants mentioning, %)

Category	**Definition**	**Example quotes**
Reminding (44,67.70%)	Remind the user of their schedule, physical condition, and home security, etc.	I usually can't remember some things, or I have a date with others, so that it can remind me. (P14)
Home security monitoring (40, 61.54%)	Monitor home security, such as gas leaks and break ins.	Monitor home security to help me to check whether the door is locked when I'm going to sleep, and check whether I turn the gas off. And help me turn the gas off if I forget. (P8)

Health monitoring (26, 40.0%)	Monitor the user's physical condition, such as blood pressure, etc.	It can know I am sick today and monitor my blood pressure. (P49)
Doing domestic tasks (18, 27.69%)	Do household chores, such as sweeping the floor.	I want MiRo to do housework and help me wash clothes, sweep the floor. (P15)
Fall detection (15, 23.08%)	Sense that the user has fallen and assist with the situation.	If I'm falling at home, no one knows; MiRo could do something for me. (P15)
Answer questions and give advice (11, 16.92%)	Answer questions and give advice.	It would be telling the temperature today and advising about wearing (P61)
Fetch objects (7, 10.77%)	Fetch objects for the user.	Let MiRo pick up the cigarette for me. (P12)
Cook (2, 3.08%)	Cook for users.	I want MiRo could cooking. (P14)
Connect with others (1, 1.54%)	Help users get in touch with others, such as voice calls.	I can use it to connect or send messages to others. (P7)
Leave messages (1, 1.54%)	Leave a message to someone you live with.	Leave a message to others who are living with me. For example, notify him of what things need to be done. MiRo will not forget to notify others, but I usually forget things. So the

		message-leaving function is good. (P7)

During the interviews, participants also expressed some other expectations for MiRo that are worth noting. Three themes were emerged, which are summarized in Table 6.7. Firstly, participants believed that MiRo must be able to "Speak Chinese" and communicate ("Communication") with them in Chinese. Secondly, participants hope that MiRo can be used as a "Voice control platform", so participants can issue commands by voice in order to operate other household appliances through MiRo, in effect acting as a smart home control platform. Finally, participants wanted MiRo to be omnipotent and to have as many functions as possible.

In addition, a new theme was derived since MiRo is a pet-type robot, which is participants want MiRo to be a bionic robot like a real pet to have a mind of its own or to be like a robot to fully obey orders. 16 participants discussed the topic, most participants (75.0%) hope MiRo could have both the characteristics of not only having its own personality like a real pet but also be able to obey commands completely like a robot. In addition, they also want the MiRo could have the ability to transfer between modes of behaviour, so that Miro can obey commands when the participants want it to be perfectly obedient and behave like a pet when the participants want it to be a real pet. Only four (25.0%) participants wanted it to be able to follow commands entirely and without any personality. A chi-square test showed this was a significant difference ($\chi2$ (1) = 4.00, $p < 0.05$).

Table 6.7: Older Chinese participants' other expectations of MiRo

Categories	**Definition**	**Example quotes**
Voice control platform (14, 21.54%)	MiRo should be able connect and control other household appliances as a voice control platform.	It could switch on the TV. It is better to have this function similar to a smart home. (P21)
Speak Chinese (4, 6.15%)	Voice interaction and communication in Chinese.	It has to speak Chinese and communicate in Mandarin. (P17)

Comprehensive functions (2, 3.08%)	Have comprehensive functions	I want MiRo could do anything. (P24)

6.3.3 Older Chinese people's worries about using the MiRo robot

The majority of participants (31, 47.69%) who discussed the topic indicated that they did not have any worries of using MiRo robot, while only five (7.69%) participants said they had worries. A chi-square test showed this was a significant difference ($\chi 2$ (1) = 18.778, $p < 0.001$).

Table 6.8 shows the four themes related to worries that were mentioned by participants. Firstly, although most participants thought it was easy to use MiRo, some were still worried they would not be able to use MiRo well. Secondly, they worried that if the MiRo robot is broken, they would not know how to deal with that or repair it. Thirdly, participants worried that MiRo would leak their personal information ("Privacy and security concerns"), such as their home addresses. Finally, participants felt that Miro was a high-tech product; thus, they worried that the price would be too expensive to afford.

Table 6.8: Older Chinese participants' worries of using MiRo robot

Categories	Definition	Example quotes
Easy to use (5, 7.69%)	The degree of using the MiRo robot would be free of effort	I'm concerned I don't know how to use it. (P8)
Maintain and repair (4, 6.15%)	MiRo robot maintain and repair issues	I'm worried about how to repair it and customer service after I bought it. (P16)
Privacy and security concerns (4, 6.15%)	MiRo robot would leak users' information	I'm worried about privacy leakage; smart technologies might cause this problem. (P24)
Affordable	The price of MiRo robot	We are worried about

(2, 3.08%)	would be reasonable and affordable	whether we can accept the price. (P44)

6.3.4 Older Chinese people's attitudes toward the MiRo robot according to the Almere model

RQ5 explored older Chinese people's attitudes toward the MiRo robot using the Almere model questionnaire. Cronbach's Alpha test was used to assess the internal consistency of the Almere questions. The alpha values for the constructs are presented in Table 6. In general, alpha values of at least 0.6 are considered acceptable for short instruments with constructs with a small number of items (Schmitt, 1996). Only the Social Influence (SI) construct had an unacceptably low alpha value (0.35). In terms to the remaining constructs, alpha levels ranged from the just acceptable (Social Presence, SP, 0.64) to the very good (Attitude toward Technology, ATT, 0.90). The SI construct may have a low alpha as it was not perceived as relevant to MiRo by participants. However, it is kept in the analysis for completeness. Thus, the internal consistency of the Almere constructs was in general satisfactory.

Only the ratings on the SP construct were normally distributed, the other constructs had skewed distributions; thus, the SP construct was analyzed using a one sample t-test, and the other constructs were analyzed using one sample Wilcoxon signed rank tests. These tests compared the distribution of scores of each construct with the midpoint of the 5-Likert scale to investigate whether participants had positive, negative or neutral views about MiRo on each construct. Note that a low rating indicates agreement with the items and a high rating disagreement with the items. Therefore, low ratings indicate positive attitudes towards MiRo, apart from on the ANX construct, for which high ratings indicate a lack of anxiety and therefore a positive attitude.

Table 6.9 and Figure 6.6 show the median scores on each of the Almere constructs. All components, apart from ANX, were significantly below the midpoint of the rating, showing positive ratings by participants. On the other hand, ANX scores were significantly above the midpoint, indicating participants were not anxious about using the MiRo robot and did not find it intimidating. However, the median score was less than one point above the midpoint, perhaps indicating that participants were also not fully relaxed about MiRo.

Table 6.9: Overview of the statistical analysis of the Almere Model Questionnaire

Construct (Code)	Number of Items	Cronbach's Alpha	Median	Semi-Interquartile range	Wilcoxon/t test	p value
Anxiety (ANX)	4	0.72	4.00	0.5	5.95	< 0.001
Attitude towards technology (ATT)	3	0.90	1.33	0.5	-6.93	< 0.001
Facilitating condition (FC)	2	0.79	2.50	0.5	-4.45	< 0.001
Intention to Use (ITU)	3	0.87	3.00	0.5	-3.99	< 0.001
Perceived adaptiveness (PAD)	3	0.76	2.00	0.5	-5.67	< 0.001
Perceived Enjoyment (PENJ)	5	0.80	2.00	0.5	-6.72	< 0.001
Perceived Ease of Use (PEOU)	5	0.71	2.40	0.5	-5.78	< 0.001
Perceived Sociability (PS)	4	0.87	2.00	0.5	-6.44	< 0.001
Perceived Usefulness (PU)	3	0.83	2.00	0.5	-6.27	< 0.001
Social Influence	2	0.35	2.00	0.5	-5.62	< 0.001

(SI)						
Social Presence (SP)	4	0.64	2.20	0.5	-9.75	< 0.001

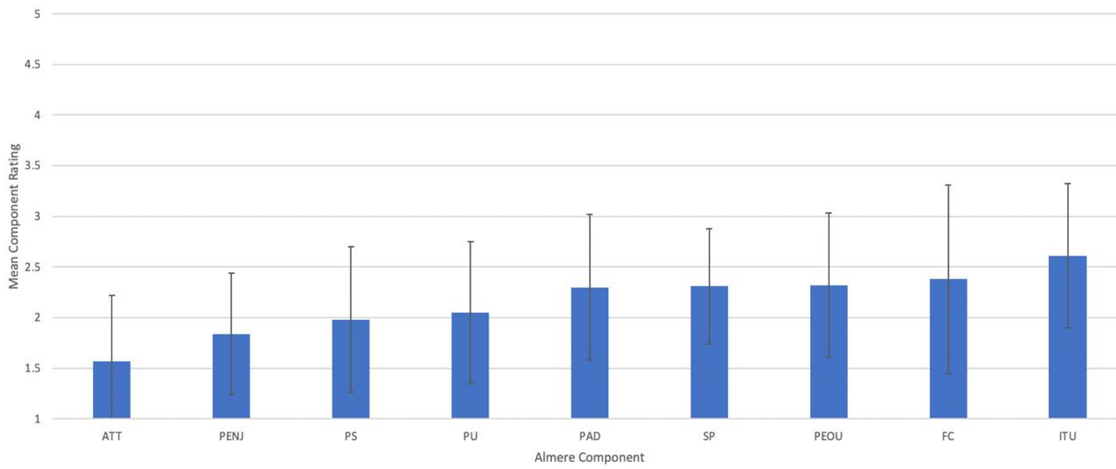

Figure 6.6: Mean ratings on nine of the Almere model components

A Friedman's non-parametric repeated measures analysis of variance by ranks was conducted to explore differences between the scores on the individual components (for this analysis ANX was omitted as it is a negative attitude and SI was omitted as the internal consistency was not satisfactory). This showed a significant difference between the components ($\chi^2(8) = 153.71$, $p < 0.001$). Post hoc tests (the Bonferroni test) showed that ATT, the overall attitude to the MiRo robot was the most positive score, significantly more positive that all other component scores ($p < 0.01$). Strangely, ITU, intention to use, was the least positive score (although significantly below the midpoint, as noted above), which seems at odds with the very positive overall attitude. However, this may reflect the fact that the participants knew they would not have the opportunity at the moment to have a MiRo, as it is a research prototype. The other components ranged between these two extremes, with PENJ (perceived enjoyment) and PS (Perceived Sociability) receiving very positive scores.

RQ4 investigated whether the results of the Almere model support the results of the qualitative data, and thus provide an accurate estimation of participants' views. So, the results on the Almere model components were compared with the interview results.

ANX: ANX scores (median: 4.00) were significantly above the midpoint, indicating participants did not agree with the Almere model statements, which means they were not anxious about using the MiRo robot. From the interview, many participants (31, 47.69%) said they did not have worries about using MiRo and thought it was not dangerous, which could support the result of the Almere model. One participant commented:

> The sellers would teach me how to use it when buying it. (P2, male, 62 years old)

ATT: ATT scores (median: 1.33) were significantly lower than the midpoint, indicating participants agreed with the Almere model's statements, which means participants hold positive attitudes toward the MiRo robot. From the interview result, 62 participants (95.38%) indicated that they would be happy to have MiRo in their home, while only two participants did not want to have MiRo. One participant commented:

> Of course, I'm happy (to have MiRo), how convenient this is. And it can help me call our child. (P19, male, 61 years old)

FC: FC scores (median: 2.50) were significantly lower than the midpoint, indicating participants agreed with the Almere model's statements, which means participants have everything that they need to use the MiRo robot, and they have confident to use the MiRo robot well. From the interview, one participant commented:

> I can operate by voice. (P1, male, 62 years old)

ITU: ITU scores (median: 3.00) is the midpoint of the scale, indicating participants were not sure whether they would use the MiRo in the future. From the result of the interview, some participants believed that MiRo was a high-tech product that was not yet widely used. They had not seen anyone using a pet robot in their daily lives. Thus, they thought their generation might not be able to use MiRo. It aligns with the result on ITU. One participant commented:

> I don't think our generation can use it (robots will be developed in the future). (P20, male, 60 years old)

PAD: PAD scores (median: 2.00) were significantly lower than the midpoint, indicating participants agreed with the Almere model statements, which means they thought the MiRo would be adaptive. From the result of the interview, participants mentioned several times that they felt that MiRo could companion them when they were staying at home lonely or help them when they needed it, which was useful for them. One participant commented:

> I believe it will be able to do these things in the future (similar to Xiaoai, which can control household appliances). (P19, male, 61 years old)

PENJ: PENJ scores (median: 2.00) were significantly lower than the midpoint, indicating participants agreed with the Almere model's statements, which means participants could perceive enjoyment from the MiRo robot. From the result of the interview, 41 (63.08%) participants want to play with MiRo. In addition, in the results from the thematic analysis about MiRo as a companion, participants emphasized entertainment as potential aspects of MiRo, and they will treat MiRo like a pet. One participant commented:

> Like raising puppies and kittens, play with them and tease it. (P22, female, 60 years old)

PEOU: PEOU scores (median: 2.40) were significantly lower than the midpoint, indicating participants agreed with the Almere model's statements, meaning they thought using the MiRo robot was easy. From the result of the interview, one participant commented:

> This is an intelligent product, so I can operate by voice. (P1, male, 62 years old)

PS: PS scores (median: 2.00) were significantly lower than the midpoint, indicating participants agreed with the Almere model's statements, which means participants could perceive the sociability of the MiRo robot. In the results from the thematic analysis about MiRo as a companion, participants emphasized communication as a potential aspect of MiRo. One participant commented:

> It can communicate with the elderly who live alone, can talk and accompany with older people, and can understand what they say. (P17, male, 60 years old)

PU: PU scores (median: 2.00) were significantly lower than the midpoint, indicating participants agreed with the Almere model's statements, which means participants could perceive the useful of the MiRo robot. From the interview result, 24 (36.92%) participants hoped that MiRo could do more task-oriented functions, and 16 (24.62%) participants wanted MiRo to serve both companion and assist roles. In addition, all participants (63, 96.92%) who responded to the task-related questions indicated that they would be willing to have MiRo help them look after their health and remind them to take medicine. One participant commented:

> If I'm falling at home, no one knows; MiRo could do something for me. (P15, female, 64 years old)

SI: SI scores (median: 2.00) were significantly lower than the midpoint, indicating participants agreed with the Almere model's statements, which means participants thought others would like them to use the MiRo robot and it would give a good impression. Although the participants did not emphasize the SI-related topic during the interview, they mentioned several times that if MiRo was popularized in daily life or their friends and relations were using it; then they would use Miro accordingly.

SP: SP scores (median: 2.00) were significantly lower than the midpoint, indicating participants agreed with the Almere model's statements, which means participants thought MiRo was a living creature. From the result of the interview, many participants mentioned that MiRo was like a real pet or they could have real feelings for the MiRo. One participant commented:

> It can talk to me, and I can tease and stroke it. Looks its eyes look like children's eyes. (P8, female, 85 years old)

Therefore, the results from the Almere model are consistent with the results from the qualitative data.

6.3.5 A more concise model compared to the Almere model

As discussed in the Introduction, the Almere model constructs are theoretically derived from the UTAUT model and not directly evidence-based with older people. Therefore, RQ6 investigated whether there is a smaller number of underlying constructs which would account for older Chinese people's attitudes to MiRo by conducting a Principal Components Analysis (PCA) was conducted on the ratings of 39 statements of Almere model questions.

Solutions with three, four and five factors were analyzed both for the strength of the component loading (only items with a component loading of over 0.500 were considered) and the semantic grouping of the items. A four components solution made the most sense. As illustrated in Table 6.10, this solution explained a total of 54.49% of the variance. 31 out of the 39 statements of the statements loaded onto these four components.

Component 1 includes 18 statements, which are about kind of the acceptance of the robot, then enjoyable and useful, and it does have social presence. Thus, component 1 was named “Acceptance and enjoyment.”

Component 2 includes four statements, which is the “Anxiety” construct of the Almere model. The result agreed with the Almere model; thus, component 2 was named “Anxiety.”

Component 3 includes six statements, which are intention to use, and have the intention to use robots with certain conditions. Thus, component 3 was named “Intention to use conditions.”

Component 4 includes four statements, which cover two aspects of adaptability. One is the MiRo robot’s adaptability, and another is the user’s adaptability. Thus, component 4 was named “Human-Robot Adaptability.”

According to the new model, one sample Wilcoxon signed rank test was used to analyse the participants' attitudes toward the MiRo robots. These tests compared the distribution of scores of each component with the midpoint of the 5-Likert scale to investigate whether participants had positive, negative or neutral views about MiRo on each component. Regarding the "Acceptance and enjoyment" Component, the median score was 2.0 (SIQR = 0.50), ranging from 1 to 4. A Wilcoxon Signed Rank test shows participants hold significantly positive attitudes toward the MiRo robot and enjoy interacting with it ($Z = -6.86$, $p < 0.001$). Regarding Component 2, "Anxiety", this component measures negative attitudes; thus, I flip the data to align with the other components. Then, the median score was 2.0 (SIQR = 0.50), ranging from 1 to 5. A Wilcoxon Signed Rank test shows participants significantly no anxious about the MiRo robot ($Z = - 6.07$, $p < 0.001$). For Component 3, "Intention to use conditions", the median score was 2.5 (SIQR = 0.50), ranging from 1 to 4. A Wilcoxon Signed Rank test shows no significant difference in participants' intention to use or not intend to use the MiRo robot ($Z = -5.33$, $p < 0.001$). Regarding Component 4, "Human-Robot Adaptability", the median score was 2.0 (SIQR = 0.50), ranging from 1 to 5. A Wilcoxon Signed Rank test shows participants significantly could perceive adaptability from the MiRo, and they are adaptable ($Z = -4.92$, $p < 0.001$)

A Friedman's non-parametric repeated measures analysis of variance by ranks was conducted to explore differences between the scores on the individual components. This showed a significant difference between the components ($\chi2(3) = 45.09$, $p < 0.001$). The post hoc test (Bonferroni) shows that "Attitudes and enjoyment" are significantly more positive than "Human-Robot Adaptability" ($p < 0.05$), even though the median score of these two components is the same. In addition, the post hoc test shows the "Intention to use conditions" was significantly more negative than "Attitudes and enjoyment" and "Anxiety" (all comparisons $p < 0.001$). The rest of the pairwise comparisons do not show significantly different.

Table 6.10: Component loadings of the Almere Model Questionnaire in the principal components analysis

Statement	**Comp 1 Acceptance and enjoyment**	**Comp 2 Anxiety**	**Comp 3 Intention to use conditions**	**Comp 4 Human-Robot Adaptability**
% of variance	35.01	7.57	7.06	5.85
I think the robot is useful to me	.918	.006	-.033	-.051
I think the robot is nice	.884	.083	.142	-.061
I consider the robot a pleasant partner	.882	-.167	.128	-.172

I find the robot fascinating	.797	-.046	.039	-.025
I have everything I need to use the robot	.770	.024	.019	.007
I find the robot enjoyable	.760	-.006	-.259	-.013
It would be convenient for me to have the robot	.734	-.066	-.101	.066
I find the robot pleasant to interact with	.732	-.272	.124	-.047
It sometimes felt as if the robot was really looking at me	.721	.424	.096	.055
I enjoy doing things with the robot	.720	-.169	-.113	-.020
It's good to make use of the robot	.689	-.082	-.087	.051
When interacting with the robot I felt like I'm talking to a real pet	.669	.348	-.040	-.008
The robot would make life more interesting	.654	-.176	-.130	.129
I enjoy the robot talking to me	.610	-.092	-.135	.052
I can imagine the robot to be a living creature	.584	.335	.044	.167
I think it's a good idea to use the robot	.599	-.142	-.126	.188
I know enough of the robot to make good use of it	.574	-.095	-.099	.142
I feel the robot understands me	.503	.112	-.191	.135
I find the robot intimidating	-.013	.685	.044	-.100
I find the robot scary	-.161	.671	.095	.115
If I should use the robot, I would be afraid to break something	-.002	.656	-.101	-.082
If I should use the robot, I would be afraid to make mistakes with it	-.013	.620	-.049	-.284
I think I can use the robot when there is someone	.115	-.052	.790	.349

around to help me				
I think I'll use the robot during the next few days	.170	-.060	-.679	.351
I plan to use the robot during the next few days	.141	-.086	-.615	.204
I think the others would like me using the robot	.161	.224	-.580	.067
I think I can use the robot when I have a good manual	.343	-.080	.532	.188
I'm certain to use the robot during the next few days	.059	-.123	-.530	.565
I think the robot will only do what I need at that particular moment	-.072	-.164	.419	.802
I think the robot will help me when I consider it to be necessary	.144	.096	.064	.796
I think I will know quickly how to use the robot	.289	-.285	-.111	.574
I think the robot would be adaptive to what I need	.436	-.092	-.103	.439
I find the robot boring	-.302	.268	-.103	.269
I find the robot easy to use	.404	-.253	-.125	.457
I think I can use the robot without any help	.229	-.407	-.088	-.088
I think the robot can help me with many things	.280	-.095	-.240	.442
I think it would give a good impression if I should use the robot	.458	-.017	.089	.088
I often think the robot is not a real pet	-.054	.202	.291	.164
Sometimes the robot seems to have real feelings	.300	.430	-.086	.315

6.4 Discussion

This study investigated older Chinese people's attitudes toward a pet robot, MiRo, to understand their attitudes and expectations of a pet robot, their preferences for the type of support a pet robot could provide, companionship or assistant, and how they would like a pet robot to support them. In relation to the first research question of the kind of animal and the gender that older Chinese people think MiRo is, they thought that MiRo is more like a rabbit or a dog. In addition, they thought MiRo is a female pet. Although it was designed to be ambiguous, older Chinese people thought of it as a rabbit or dog and female. It would be interesting in future research to explore what older people with different cultural backgrounds think the MiRo is, such as older Europeans.

On the second research question of the general attitudes to the robot and the type of support it could provide, participants were generally positive, but were evenly split between wanting a companion robot, an assistant or both. Interestingly, when asked what kinds of things they wanted the robot to do for them, all participants, including those who had asked for a companion robot, mentioned tasks the robot might do. So even though they stated their preference for a companion robot, they may well have been thinking of supportive tasks it could do as well.

This outcome is consistent with that of McGlynn, Kemple, Mitzner, King, and Rogers (2017) who found that older American adults had positive attitudes towards the pet robot Paro. Despite different pet robots being used in the two studies, both older American people and older Chinese people showed positive attitudes toward using pet robots. But this outcome is contrary to the results of Study 3 which found older Chinese people hold varied attitudes toward the companion pet robots. In that study, some older Chinese people hold positive attitudes toward the companion pet robots, while some older Chinese people hole negative attitudes toward the companion pet robots.

In addition, the outcome is also contrary to that of Huang and Huang (2020) who found older Chinese people hold varied attitudes toward companion robots. Huang and Huang (2020) found that older people living with family members and had experience of using technology products, and those with high education and medical professional backgrounds, had more positive attitudes toward companion robots, while older people without experience of technology products, with only primary education, tended to have negative attitudes towards them. Despite the fact that the influence of participants' background factors was not considered in this study, the participants were recruited in various methods, including through recommendations given by my relations and by a social institution (a facility with a nursing home and independent but support living apartments). However, regardless of the circumstances, these participants generally hold a positive attitude toward robots. A possible explanation for this might be that the participants in the Huang and Huang's study did not interact with any companion pet robots; participants only received an oral introduction about the companion pet robot. In Study 3, participants watched videos to receive information about robots, but they did not interact with the robot. However, the participants in McGlynn, Kemple, Mitzner, King, and Rogers's (2017) study did interact with Paro. Participants in this study interacted with the MiRo robot themselves as well as watching me interact with it, which gave them a detailed impression of what it is like. These findings suggest that older Chinese people hold a positive attitude toward the MiRo robot as a companion, especially after interaction with the robot. But further analysis is needed to further how older people's initial experience of one pet robot would affect their overall attitude toward pet and other types of robots and how their attitudes evolve with use of a robot over a period of time.

Regarding the third research question of older Chinese people's attitudes and expectations of the MiRo robot as a companion, the study found that participants wanted to be able to talk with the robot, exercise with it and entertain themselves with it. In addition, it is worth mentioning that some participants wanted the MiRo robot as an assistant to perform tasks for them, but their attitudes towards the MiRo robot as a companion were positive. It is possible, therefore, although some older Chinese people want MiRo as an assistant to perform tasks for them, they could also accept MiRo as a companion. The most surprising thing perhaps was that participants wanted to take the robot for a walk outside, like a dog. In hindsight, this is not surprising, as MiRo does look somewhat like a dog, but was not a function the researchers had expected. This finding is consistent with that of Guerra et al. (2022) who reviewed and summarized older people's expectations of companion pet robots from existing studies; the study summarized older people's expectation of companion pet robots into three categories, which are: is like a real pet, but with less maintenance; performs multiple functions, with customizability; facilitates interactions without promoting social stigma.

In terms of the fourth research question of older Chinese people's attitudes and expectations of the MiRo robot as an assistant to perform tasks for them, the study found that older Chinese people would like MiRo to help them in particular with looking after their health and with a wide range of tasks in daily life, both physical ("Doing domestic tasks", "Fetch objects") and mental ("Reminding", "Providing information"). While some of these tasks may be beyond the capabilities of a pet robot, many of them could be programmed into robots such as MiRo and many of these tasks have been discussed in the research literature, largely from Europe and North America, on technologies to support older people living independently (Petrie & Darzentas, 2020). Surprisingly, the majority of the functions that older Chinese people want MiRo to do are highly overlap with a study conducted by Samaddar and Petrie (2020), who found what older British people actually want from their robots, such as "Reminder", "Home security monitoring", "Cooking", "Fetch objects", and "Entertainment." In addition, some participants wanted the MiRo as a companion type robot, but their attitudes towards the MiRo robot as an assistant to perform tasks for them were also positive. The findings reported here suggest that although some older Chinese people want MiRo as a companion robot, they could also accept MiRo to assist them in daily life. According to the results from RQ2, RQ3, and RQ4, we can infer that older Chinese people have a preference for the type of the support that the MiRo robot can gave, but they have a positive attitude towards the MiRo robot as a companion and as an assistant in performing tasks.

The fifth research question investigated whether the Almere Model is useful in understanding older Chinese people's attitudes toward the MiRo robot. This was investigated by asking participants to complete a version of the Almere Model Questionnaire and comparing the data with that from the interview results. All components of the Almere model are almost in line with the interview results. Only the component of SI was not mentioned by participants during the interviews. The fact that there was not anything related to that does not mean they did not think things about it, and it is just that they did not bring it up in the interviews. Almost all 11 components were validated, there has evidence for each of them. Thus, although the Almere Model was developed in the Netherlands and for assessing the attitudes and acceptance of very different types of robots for older people, it was robust in providing a useful quantitative measure with older people in China.

The final research question explored whether there is a smaller number of underlying components of the Almere model questions that would account for older Chinese people's attitudes to the MiRo robot. This study conducted a new analysis of the questions from the Almere model questionnaire. The analysis shows a smaller number of underlying constructs explains over half the variance of people's attitudes. For the 39 statements in the Almere model, 31 statements are accounted for by the new model with only four components, rather than the 12 constructs (components) of the Almere model. In addition, the new model uses all of the constructs from the Almere model, but grouped them into four components. In four components, this new model covers 10 of 11 components from the Almere model ("Trust" was not investigated in this study). Thus, this new model covers ideas in the Almere model, but much more concisely. For future work, the next thing to do would be to make a short scale taking the highest statements; for example, for the "Acceptance and enjoyment" component, the new model has 18 statements; if we go down the component loading of over 0.700 were considered, then, the "Acceptance and enjoyment" component will only have 10 statements. The questionnaire will be used again for future work. This new questionnaire could be developed further by creating a short scale based on the result of the PCA analysis. Another point worth mentioning is that in the open-ended questions (Study 2), participants did not use many of the Almere model constructs, but participants did rate them positively when they did the Almere model questionnaire in this study.

From the new model, the older people thought using the MiRo robot was acceptable and enjoyable, and they thought they would adapt to the MiRo and that MiRo would adapt to them. They were a little less sure about whether they intended to use it because the median score on the intention to use component is only 2.50, but the midpoint is 3.0. However, they were not anxious about it. Therefore, the new model shows older Chinese people have an overall positive attitude. This result supports the results from the interviews which also showed that older Chinese people hold positive attitudes toward the MiRo robot. Thus, this new four component model could also be useful in studying older people's attitudes toward robots. However, the robot that was used in the study was a pet robot, and the participants were only from China. Therefore, further studies involving a wider range of robots and older people with different cultural backgrounds is suggested, such as older European and American older people to further explore the possibility of a more evidence-based quantitative measure of older people's attitudes to robots. In addition, those four components have not been validated in the study; it is worth further research to validate whether those statements could be categorized into the component correspondingly. Moreover, in the HCI research area, we analyze in terms of "Usability," the current ISO (International Standards Organisation) definition of Usability in ISO 9241-11:2018[28] covers three components, which is "Effectiveness", "Efficiency" and "Satisfaction". But looking at the Almere model's constructs, and the "Usability" components are mixed in each of the Almere construct; for example, regarding the "PEOU" construct, the statement of "I find the robot easy to use" perhaps could be catalyzed to the "Effectiveness". But the statements of "I think I will know quickly how to use the robot", "I think I can use the robot without any help", "I think I can use the robot when there is someone around to help me," and "I think I can use the robot when I have a good manual" do not look like "Effectiveness", and further research should investigate that.

The study used qualitative and quantitative methods to assess older Chinese people's attitudes toward the MiRo robot. In addition, participants in this study not only interacted with the robot MiRo, they also watched videos about MiRo, which helped the participants to have a good understanding of MiRo and its capabilities. The use of the videos was partly practical, in case MiRo would not function during the study sessions, but they also served an important methodological point in the study, in that it meant participants were able to see a number of aspects of the possible capabilities of the robot, Nonetheless, the participants only had a brief introduction to MiRo: the demonstration by the researcher, their interaction with the robot and the videos. It would be interesting in future work to explore how longer, more indepth interaction with the robot would influence older people's attitudes. There may be a novelty effect at play here, a design challenge explored by de Graaf, Allouch and van Dijk (2017) in relation to robots.

The major limitation of this study is the participants all lived in an urban area and probably had good experience with technology. Further work is needed to understand the attitudes toward robots of older Chinese people who live in the rural area. In addition, the study did not take into account the factor of the educational and professional backgrounds of the

[28] URL: https://www.iso.org/obp/ui/#iso:std:iso:9241:-11:ed-2:v1:en

participants, as it is considered inappropriate to ask this generation of older Chinese people about their educational and professional backgrounds.

6.5 Conclusions and future work

The main goal of the current study was to understand the attitudes and expectations of older Chinese people of a pet robot as a possible companion and assistant robot to perform tasks in relation to health and daily living. The study used the MiRo as an example pet robot. The study found that older Chinese people hold positive attitudes toward the MiRo robot in both these areas. In addition, the study showed that the Almere model could be used to assess older people’s attitudes toward pet robots, which could assist in studying the attitudes of older people to robots, providing quantitative data on multiple dimensions. The results from the Almere model as a quantitative method align well with the qualitative data from the interviews and group interviews and can complement the qualitative data. In addition, this study analyzed the Almere model questions and produced a set of four components which account for a substantial proportion of the variance in older Chinese people’s attitudes to MiRo. This model could also be useful in understanding older people’s attitudes to robots with further development.

The study contributes to our understanding of the attitudes of older Chinese people towards robots, especially their views on the use of pet robots as companions and assistants. In addition, this project is to the best of my knowledge, the first investigation of older Chinese people's perceptions of using pet robots to assist them in daily life rather than only having a pet robot as a companion or toy. The results of this study showed that for older Chinese people, pet robots might not only be used as companionship or treatment in nursing homes or hospitals, but also have potential to assist healthy older people in living independently. Thus, the findings reported here shed new light on using pet robots to assist older Chinese people, especially for healthy people living outside the institutions.

With the rapid growth of the Chinese aging population, old-age care has become an urgent problem in China's current society, which have generated widespread concern from both the society and government in general[29]. Using technologies to assist and care for older people has been recognized as a potential solution to the problem[30 31]. Small pet robots may have more potential to act as companions and assist older people in the home environment than large humanoid robots. Future development is needed for multifunctional pet robots for older people that can be used in many aspects of their daily life.

29 URL: https://www.ndrc.gov.cn/fggz/fgjh/yxyd/202012/t20201227_1260455.html
30 URL: https://www.mca.gov.cn/article/xw/mtbd/202101/20210100131839.shtml
31 URL: http://www.npc.gov.cn/npc/c30834/202203/813d4151d21941ffb4c130f0c5817606.shtml

Chapter 7 Overall discussion and conclusions

7.1 Overall of the programme of research

As the global population of older people increases, many countries worldwide have become aging societies, including China. It is essential to explore innovative solutions that can enhance the well-being and independence of this growing population of older people. Technologies and robots have demonstrated their ability to provide valuable support in various domains, including healthcare, companionship, and household tasks. The integration of technologies and robots in the lives of older people offers numerous advantages. These technologies can assist with activities of daily living, such as medication reminders, mobility support, and household tasks, thereby promoting independence and reducing the burden on caregivers. Moreover, robots can potentially offer emotional support and companionship, reducing feelings of loneliness and isolation among older people, which are common challenges in aging societies. Therefore, enhancing the user experience of technologies and robots for older people and facilitating their adoption and use holds great potential for improving their quality of life and the well-being of this population. In addition, it is crucial to address the unique challenges faced by older people in interacting with and using robotic technologies effectively. In the circumstances, to improve the user experience for older people and help them better use new technologies and robots, the first step is to understand their attitudes toward new technologies and robots, and their expectations of using technologies and robots to help them in daily life.

The literature review showed that research on technology for older people mainly focuses on three aspects (Chapter 2, section 2.6): assistive technologies (McCreadie, 2002; Sinn & Poupart, 2011), healthcare technologies (e.g. Czaja, 2016), and information and communications technology (e.g. Czaja, 2017). While robots developed for older people are mainly focussed on two types of functions (Chapter 2, section 2.7): companionship (e.g. Wada & Shibata, 2007; Heerink et al., 2013; Tkatch et al., 2021) and undertaking specific tasks to support independent living (e.g. Graf et al., 2004; Wu, et.al., 2014; Petrie & Darzentas, 2017). Research has shown that older people have already been using various technologies in their daily lives and hold a positive attitude towards technology (e.g. Fausset et al., 2013; Chan & Chen, 2016; Vaportzis et al., 2017;) (see Chapter 2, section 2.8.2). In terms of robots, existing studies tend to investigate older people's attitudes toward a single robot type. Thus, regarding older people's attitudes toward companion pet robots, results from several studies showed that older people tend to hold positive or neutral attitudes toward companion pet robots (e.g. Bradwell et al.,2019; Huang & Huang, 2020; Van Orden et al., 2022) (see Chapter 2, section 2.8.3.1). Concerning older people's attitudes toward task-oriented robots (see Chapter 2, section 2.8.3.2), although some studies show that older people tend to hold negative attitudes toward robots (e.g. Wu et al., 2016; Trajkova & Martin-Hammond, 2020), most previous studies show that older people hold positive attitudes toward robots and accept using them in daily life (e.g. McColl & Nejat., 2013; Smarr et al., 2014; Bedaf et al., 2018). However, there are many gaps in this research area that have not been investigated; for example, the existing studies are usually conducted in Western countries, and no previous study has compared older people's attitudes toward different robot types (see Chapter 1; Chapter 2, section 2.8 and 2.9).

Therefore, the aim of this programme of research was to comprehensively and systematically investigate the attitudes of older Chinese people toward digital technologies and robots. In particular, this programme of research compared the attitudes of older Chinese people towards different types of robots, explored their expectations for different types of robots, and which type of robots they preferred. In addition, as a preliminary study this programme of research investigated the attitudes of young Chinese people towards older people as technology users, and then compared their perceptions with older people's attitudes.

This research programme started by investigating whether young people, as current and future designers and developers of technologies for older people, have ageist and sexist attitudes about older people as users of technology, their definition of older people, and to investigate whether their attitudes differ from those of older people (Study 1, Chapter 3). The study found that young and old Chinese people have ageist attitudes about older people as users of technology; they hold negative attitudes towards older adults compared to young ones as both users of and experts in technology. However, although young Chinese technologists did not have sexist attitudes about women, they do have a “double standard' for older women as being perceived negatively in the likelihood of using technologies compared to old men and young women. Older Chinese people do not have sexist attitudes about women, and they do not have a "double standard' for older women.

This study supports evidence from a previous study (Petrie, 2018) that found British young technologists have ageist attitudes about older people as technology users. But in terms of the young technologists' sexist attitudes, this outcome is different from that of Petrie (2018), who found women were perceived as less expert with the technologies than men by British technologists, but there was no evidence of a "double standard" in Petrie's study. Although the participants in this study and Petrie's study have different cultural backgrounds, young technologists hold the same ageist attitudes and beliefs about older people, but they have slightly different sexist attitudes. In addition, the study identified that young and old Chinese people hold differing views on the minimum age of older people; young Chinese people thought that adults over 60 years as older people, but older Chinese people thought older people should be aged over 65 years. However, this result has not previously been described.

The contribution of this study provides the first assessment of young Chinese technologists and older Chinese people’s attitudes toward older people using and being expert with modern technologies. This helps young technology developers become aware of and understand the differences in perceptions between young and older people, which could help them design technologies suitable for older people. Besides, because of the variations in the definitions of older people among different institutions and countries, this programme of research conducted the first investigation into Chinese people's definitions of older people, which will provide a reference for future research, especially for research related to older Chinese people. In addition, the study provides evidence that could support young technologists with different cultural backgrounds holding the same attitudes (ageist attitudes) about older people as users of technology, but they have different attitudes about women as users of technology. Therefore, positive education is needed to address young people’s ageist attitudes in both the UK and China. The reasons for the different attitudes (sexist attitudes) of Chinese and British young computer scientists are still unanswered, and it is worth exploring in future work.

This programme of research then moved on to investigate older Chinese people’s attitudes toward technology and robots, in order to gain a more comprehensive understanding of these attitudes (Study 2, Chapter 4). Study 2 investigated the technologies commonly used by older Chinese people in their daily lives, as well as their purposes and experiences in using these technologies. This study found that older Chinese people use various digital technology products to achieve different purposes in their daily lives. For example, they use smartphones to contact others and vacuum robots to clean. In addition, they have both positive and negative attitudes to the digital technologies they use in their daily lives. Their positive attitudes were mostly focused on the “Provide access to specific services”, while their negative attitudes were mostly focused on the attributes of devices and their “Negative emotional reactions” to them. These results support evidence from previous studies in other countries that have shown that older people use a variety of technologies to achieve different purposes in daily life, and the participants in these studies also hold both positive and negative attitudes in relation to different aspects of technologies (Fausset et al., 2013; Mitzner et al., 2010; Frennert & Östlund, 2015; Quan-Haase et al., 2018). Therefore, this study fills a gap in research on older people’s use of and attitudes toward technology in the context of Chinese cultural background. Thus, the contribution of this study was an investigation of older Chinese people's technology usage behaviour, which includes the technologies they use in daily life, the purposes and experience in using those technologies, and the experience of learning to use technologies. This helps us understand the entire technology use process among older Chinese people, including the aspects they value and their concerns when using technology, which could help technology developers design technologies that meet the needs of older Chinese people. In addition, this study was conducted during the COVID-19 pandemic, so the impact of the COVID-19 pandemic on the use of technology among older Chinese people was also investigated and found that although older Chinese people’s use of technologies did not have many changes, the COVID-19 pandemic promoted more positive attitudes toward technologies by older Chinese people.

In addition, Study 2 explored the attitudes of older Chinese people toward new technologies that they have not used before. It found that older Chinese people are interested in and hold positive attitudes toward technologies they have not used before. Factors which affect whether they decide to use a new technology include “Perceived usefulness”, “User’s needs”, “Social influence”, “Facilitating conditions”, “Good quality and safety”, “Older products have to be replaced or upgraded”, and “Perceived ease of use”. These results partly support the existing technology or robot acceptance models (Davis， 1985; Venkatesh et al., 2003; Heerink et al.， 2010； Chen & Chan, 2014), such as “Perceived usefulness”, “Facilitating conditions”, “Social influence”, and “Perceived ease of use”. However, “Perceived ease of use” has often been regarded as an important influencing factor in those models, but it was only mentioned by a few participants in this study. In addition, an important influencing factor of "user's needs" was highlighted by participants; although this factor was not included in those models, this factor was also highlighted by older Swedish people in Frennert and Östlund's (2020) study. Therefore, these results show that existing technology or robot acceptance models may not be applicable in the context of Chinese culture or that these models may not be suitable for investigating older people's attitudes toward technology nowadays. A new model is needed for measuring older peoples' attitudes toward technology.

One of the contributions of this study has been to confirm that older Chinese people hold positive attitudes toward new digital technologies, and they are willing to use them in the future. This means there is great potential for using technology to support older people in the future. In addition, this study contributes to our understanding of the factors that would affect older Chinese people's decision to use new technology, and this could provide evidence for proposing new models of technology acceptance among older people in the future.

Robots are one important new type of technology and Study 2 also investigated older Chinese people's attitudes toward robots. Studies 3 and 4 further developed this investigation in different ways, these were presented in Chapters 5 and 6. Thus, through Studies 2, 3 and 4 I investigated older Chinese people's attitudes to a range of robot types (companion pet robots, task-oriented table robots, task-oriented movement robots) in increasing detail.

Although these three studies all investigated older Chinese people's attitudes toward robots, each had different specific aims. In addition, the method that was used in these studies is somewhat different. In Studies 2 and 3, a qualitative method was used to explore participants' attitudes, semi-structured interviews. But Study 4 both qualitative and quantitative methods were used, semi-structured interviews and the Almere model questionnaire. In addition, the amount of information about robots presented and the mode of presentation differed between studies. In Study 2, I gave an oral descriptions of basic information about robots to participants, which included the two main robot types (companion robots and task-oriented robots) that are designed for older people, and general information about each robot type, such as functions and appearance. In study 3, I participants watched three videos that introduced three types of robots (companion pet robots, task-oriented table robots, and task-oriented movement robots). The videos demonstrated the functions, features, and how these robots interact with older people, which could help participants get more information and understanding of these three robot types. In Study 4, participants watched three videos about the MiRo robot, watched me interact with MiRo, and then interacted with MiRo themselves, such as petting MiRo.

Through these three studies, I developed a deep understanding of the attitude of older Chinese people towards robots. This includes their attitudes and preferences towards different types of robots, as well as their attitudes towards using companion pet robots to accompany them and provide assistance in daily life. In addition, through these studies, I also understand older Chinese people's expectations and concerns about the use of robots in the future.

The scope of the three studies became more specific as I worked through them. In Study 2 I asked about older Chinese people's general attitudes toward using robots in the future. The study found that older Chinese people are willing to have robots help them and will use robots in the future. They prefer a robot that combines task-oriented and social companion functions. Then, to more deeply understanding older Chinese people's attitudes toward robots, Study 3 (Chapter 5) further investigated their attitudes, preferences, and expectations toward different types of robots (companion pet robots, task-oriented table robots, and task-oriented movement robots) and which type of robots they preferred. This study has identified that older Chinese people hold positive attitudes toward both task-oriented table robots and task-oriented movement robots. However, they hold varied attitudes toward companion pet robots, such that participants aged at 60s hold positive attitudes toward this robot type, while participants aged at 70 and above hold negative attitudes. Thus, the results from this study suggest that older people's attitudes toward companion pet robots are influenced by age, but it is worth further research to confirm this. In addition, Study 3 found that older Chinese people most preferred task-oriented movement robots no matter their age group, but they hold more positive attitudes toward task-oriented table robots. However, older Chinese people do not like companion pet robots compared with other robot types. Then, in Study 4 (see Chapter 6) I concentrated on a specific pet robot. This study further deepens the investigation of older Chinese people's attitudes toward the pet robot MiRo as a possible companion and an assistant to perform tasks in relation to daily living. The study found that older Chinese people hold positive attitudes toward the MiRo robot in both these areas.

Taken together, through these studies, it can be determined that older Chinese people hold positive attitudes toward robots, especially for task-oriented robots; and they have the intention to use robots as possible companions and assistants to perform tasks in relation to daily living in the future. This study supports evidence from previous research with participants in the context of different cultural backgrounds, such as North American and European countries (e.g. Ezer et. al., 2009; Frennert et al., 2012; McColl & Nejat., 2013; Louie et al., 2014; Broadbent et al., 2014; Smarr et al., 2014; Frennert & Östlund, 2015; Lazar et al.,2016; McGlynn et al., 2017; Bedaf et al., 2018; Backonja et al., 2018; Bradwell et al.,2019; Park et al., 2019; Van Orden et al., 2022), which found older people hold positive attitudes toward robots. However, one unanticipated result was that different groups of participants in Study 3 held differing attitudes toward companion pet robots: participants aged in the 60s held positive attitudes toward this robot type, while participants aged 70 and above held negative attitudes, while in Study 4 participants held positive attitudes toward the pet robot MiRo. A possible explanation for this might be this the participants in Study 4 interacted with the MiRo robot, which gave them a good impression, and they experienced the fun of interacting with MiRo; thus, most participants had a positive attitude about using companion pet robots. However, further research is needed to determine the reasons for this difference between the two studies. It cannot just be said that the method of learning about the robot would cause this difference, as the two studies had different research aims with different variables; for example, participants in Study 3 received information about other types of robots in addition to companion pet robots and participants preferred task-oriented robots in that comparison. However, participants in Study 4 only received information about companion pet robots, and there were no other types of robots as a comparison; they held positive attitudes. Regardless, what is certain is that when participants compared different types of robots, companion pet robots were their least favourite type of robot. This result has not previously been described.

Finally, from the three studies, I learnt that older Chinese people have different expectations for different types of robots, for example, they expected that companion pet robots should have "Animal-like appearance/behaviour" and "Mobility"; and they expected that task-oriented robots could "speak Chinese". In considering robots in general, they expected the robot to have a “Human-like appearance and behavior”, and they want the robot to be a companion and assist them in daily life as a caregiver. In addition, although Study 4 focused on companion pet robots, participants did not expect pet robots to look like humans, but they still expected that companion pet robots would not only be a companion for them but also assist in their daily lives, such as taking care of their health. Thus, the results of these three studies are consistent in that older Chinese people want robots to be a companion to them and assist them in daily life. This could also explain why older Chinese people's attitudes toward companion pet robots are different in Study 3 and Study 4; in Study 3, they thought that companion pet robots could only be a companion to them without practical functions, and they did not expect that companion pet robots could assist them in daily life. But, in Study 4, they expected that companion pet robots would also assist them, as the videos showed that the MiRo could not only be a companion to them but also do practical tasks. These results agree with those of Bedaf et al. (2018) who also found that older Dutch people want robots to perform more intricate tasks akin to human caregiving, comparable to the level of care provided by a human caregiver.

These three studies also showed that older Chinese people have concerns about using robots, although many participants mentioned that they do not have any concerns about using robots. Their concerns include “Privacy and security concerns”, “Malfunction”, “Affordable”, and “Too difficult to use”. These results agree with those of Frennert and Östlund (2020) who also found that older Swedish people have the same concerns about using robots.

This investigation confirms that older Chinese people hold positive attitudes toward robots, and confirms the potential of using robots in the future to act as companions and assist older Chinese people. In addition, unlike previous studies that generally investigated older people's perceptions of a single type of robot, this programme of research examined older Chinese people's attitudes, preferences, and expectations toward different types of robots, which has provided a deeper insight into which type of robots are more likely to be used by older Chinese people in their daily life, and their perceptions about different types of robots. This provides new directions for future research on older people's perspectives on robots; and sheds new light on developing robots that older Chinese people prefer and could meet their daily needs.

Another contribution of this investigation is that it lays the groundwork for future research into older Chinese people’s perceptions of pet robots as a possible companion and an assistant to perform tasks in relation to daily living. In addition, this research is the first investigation of older Chinese people's perceptions of using pet robots to assist them in daily life rather than only having a pet robot as a companion or toy. The results of this study showed that for older Chinese people, pet robots might not only be used as companionship or treatment in nursing homes or hospitals, but also have potential to assist healthy older people in living independently.

While Studies 2 and 3 use a qualitative research method (semi-structured interviews), Stud 4 conducted with both qualitative and quantitative methods (semi-structured interviews and the Almere model questionnaire). Study 4 showed that the Almere model could be used to assess older Chinese people's attitudes toward pet robots, which could assist in studying the attitudes of older people to robots, providing quantitative data on multiple dimensions. The results from the Almere model as a quantitative method aligned well with the qualitative data from the interviews and thus can complement the qualitative data. Study 4 also provides a new model, which is more concise than the Almere model (the version of the Almere model I used include 11 constructs, as "Trust" was not included). This was reduced to four components in the new model. Thus, this new model covers ideas in the Almere model but much more concisely. However, some components still have many statements, such as the "acceptance and enjoyment" component, which has 18 statements. Thus, further research should make a short scale, taking the highest rated statements and valid such a scale.

Thus, the final contribution of this investigation provided an insight into aspects of HCI research methods for working with older people. Study 4 provides a concise new model that could be used to explore older people's attitudes toward robots, especially in the context of Chinese culture. Another contribution related to aspects of HCI methods is the programme of research employed various methods of presenting information about robots to participants and found that different approaches might impact the results of similar research.

My ultimate objective in completing this programme of research was to foster a greater understanding of older Chinese people’s attitudes toward technology and robots to develop the robots that could meet the older Chinese people’s need and help them in daily life. I hope that this programme of research could provide some information for the development of robots designed for older people and offer some insights for future research.

7.2 Limitations and future work

The research has a number of limitations which need to be highlighted. These include participant selection, the different methodologies and the measures used in each study, and the impact of the COVID-19 pandemic on the research.

Despite my best efforts to recruit as widely as possible, many of the older Chinese people who participated in this investigation had a similar background and level of experience with technology, such as smartphones. Most participants live in urban areas in China. Therefore, the results of this programme of research may be more representative of the attitudes of older Chinese people living in urban areas. Future research should investigate the attitudes of older Chinese people with a wider variety of backgrounds and levels of experience with technology and particularly those residing in rural areas. Another related limitation of the research was that it was not possible to collect information about participants' educational level and previous or current occupations. These factors undoubtedly affect their attitudes towards technologies and robots. However, for the current generations of older people these are very sensitive topics and to ask participants about them in the context of a general interview would be considered rude. Further research is needed to investigate how these variables influence the attitudes of older Chinese people toward technologies and robots.

In addition, due to the COVID-19 restrictions of the pandemic, I could not travel to China to collect data for an extended period of time. Therefore, my plans for Studies 2 and 3 changed from in-person to online interviews. Because the target population was older Chinese people, who are often not familiar enough with technology to participate in an online interview, this affected the diversity of my samples. I could only interview older people who were confident in using online chat technology. All participants in Study 2 and the majority of participants in Study 3 are older Chinese people proficient in technology, such as online chat and smartphones, which means the findings of these two studies represent the attitudes of only a section of the population of older Chinese people towards digital technologies and robots. As mentioned above, participants were proficient in technology, at least with smartphone technologies, and during the interviews, many participants showed confidence with digital technologies; thus, they might be more positive about them than a more representative sample of the population.

Another limitation is that the methods which were used in the different studies. Due to the COVID-19 pandemic, Studies 2 and 3 had to be conducted through online interviews. Online interviews may lack the personal connection and non-verbal cues present in face-to-face interactions, potentially affecting rapport and my depth of understanding during the interviews. Technical issues, such as internet connectivity problems and audio and video glitches, can also impact the quality of online interviews. For example, there were delays during the interview due to a poor network signal, I started the new topic, but the participant was still in the discussion of the last topic. On the other hand, face-to-face interviews provide a more immersive and immediate experience. The physical presence facilitates better observation of body language and facial expressions, fostering a deeper level of engagement. Face-to-face interviews often create a more intimate and trusting environment, allowing participants to feel more comfortable sharing sensitive information (Flick, 2022). Therefore, the use of online interviews may have an impact on the depth of material elicited, potentially leaving some participants' attitudes undiscovered. In addition, Study 4 was conducted using a mixed method approach, which included both individual and group interviews. This was because recruiting enough older people was a challenge in the immediate post-COVID period, so accumulating enough participants for individual interviews was not possible.

A further limitation was the possible effect of the particular videos that were used in the Studies 3 and 4. In Study 3, participants watched nine videos about three different types of robots to help them gain a greater understanding of robots. Three robots showcased in the videos are developed in Japan (Paro, Aibo, and Pepper), three in China (Nanguo, Zenbo, and Sanbot), one in the UK (MiRo), one in Israel (ElliQ) one in the Netherlands (iCat), so the videos were mainly in English (six videos were totally in English; two videos were totally in Chinese, and one video was partly in English and partly in Chinese) (Chapter5, section 5.2.3.1). A similar situation occurred in Study 4, where all of the videos about MiRo were in English since MiRo was developed by a British research group. Although I added Chinese subtitles to all the videos and provided simultaneous verbal explanations while playing the videos to the participants, the language may have had an impact on the results of these two studies. Some participants may not have fully understood the content of the videos, especially during group interviews, in which participants asked less questions. They might have hesitated to ask questions if they did not fully comprehend the video's content. This issue may then have impacted their attitudes about the robots.

An issue that was not addressed in this programme of research was whether the different methods of presenting the information about robots used in the studies would impact participants' attitudes toward robots. In Study 3, participants did not interact with the companion pet robot, only watched videos; this study found that older Chinese people held varied attitudes towards companion pet robots, and participants ranked MiRo as their second most preferred companion pet robot. In contrast, in Study 4, participants as well as watching videos about the robot, they watched me interact with the actual robot and then interacted with it themselves. In this study they held positive attitudes toward the pet robot MiRo and expressed their interest in MiRo. However, these two studies contain a number of other differences, such as the number and type of robots being presented. Study 4 is only about the pet robot MiRo, while Study 3 is about three different robot types. Thus, participants have the option of making comparisons, they might prefer other types of robots more than companion pet robots. These differences also might affect participants' attitudes toward companion pet robots. Therefore, more research using controlled situations is needed to determine whether different research methods have an impact on participants' attitudes toward robots or whether the level of understanding among older Chinese people regarding robots influences their attitudes toward them.

Another limitation of Study 4 was that the participant's subsequent use of robots was not measured in the study, although the study used the Almere model to explore older people's intention to use robots and participants did actually use the robots in the study. As mentioned in the literature review (see Chapter 2, section 2.8.1), most previous research had this limitation as well, in that intention to use is only measured through questionnaires without measuring actual subsequence use. Only one study (Heerink et al., 2008) measured participants' subsequent use of robots. In Heerink's study, participants played with the iCat robot for 3 minutes; then, they were asked to complete a questionnaire to measure their enjoyment. The iCat robot was then left in the public area of the eldercare institution where participants lived to see whether they would interact with the iCat later. The participants in my studies are independently living; thus, to study subsequent robot use it would have required giving each person a MiRo to have for a period of time, which was not possible. In the group interview situation, which took place at a centre for older people I could have left

MiRo there, and recorded whether participants used it later, but this was not practical, because I only had one MiRo which I needed for individual interviews. Therefore, further research should be undertaken to explore older people's use overall in the longer term.

In summary, following up to the results of Study 1, future studies should conduct a programme to education young Chinese technologists about ageism and the importance of designing carefully for older users, and then evaluate the programme. Following up on the results of Studies 2, 3 and 4, future research should include a field trial of different robots or different robot types in older people's homes to see their actual use and long term attitudes; including measuring attitudes before they get the robot and then tracking how their attitudes change as they have the robot over a period of time. Finally, a controlled study could be conducted to see whether the different research methods in information presentation affect older people's attitudes toward robots; one group of participants would interact with robots, and another group of participants would only get robots information through videos or pictures without interact with robot; then compare two groups participants' attitudes to see whether it is difference.

7.3 Conclusions

This programme of research investigated young Chinese technologists' attitudes to older people as technology users; older Chinese people's use and attitudes to current technologies; older Chinese people's attitudes to using new technologies they have not used before; and older Chinese people's attitudes to robots in terms of two dimensions: older Chinese people's attitudes to use robots to companion and assist them, older Chinese people's attitudes to different robot types.

In terms of young Chinese technologists' attitudes to older people as technology users (Study 1), the result shows that young Chinese technologists have ageist attitudes toward older people as users of technology, as do older Chinese people. But, although they do not have sexist attitudes toward women or men as users of technology, they have "double standard" attitudes toward older women as users of technology (they thought older women are less likely to use digital technologies); however, older Chinese people do not have a "double standard" toward older women.

Regarding to older Chinese people's use and attitudes to current technologies users (Study 2), they use a range of digital technologies for a range of different purposes in their daily lives, such as vacuum robots to help them to cleaning home. In addition, they have both positive and negative attitudes of digital technology products that they use in their daily lives. Their attitudes focused on different aspects of digital technologies: positive attitudes were mostly focused on the "Provide of access to specific services", while their negative attitudes were mostly focused on the attributes of devices and their "Negative emotional reactions" to them.

For older Chinese people's attitudes to using new technologies they have not used before (Study 2), they hold positive attitudes toward new technologies, and they willing to try new digital technology products in the future. The COVID-19 pandemic also played an important role in the positive attitudes of older Chinese people towards new technology products, because the COVID-19 pandemic has made them deeply appreciate the benefits of digital technologies.

In terms to older Chinese people's attitudes to robots, they hold positive attitudes toward robots and have the intention to use robots as companions and to provide assistance in the future (see Studies 2, 3, and 4). In addition, older Chinese people hold different attitudes toward different robot types; they hold more positive attitudes toward task-oriented robots (table and movement), and prefer task-oriented robots (table and movement) in comparison to companion pet robots, because participants thought companion pet robots have fewer practical functions. But, participants had positive attitudes after they interacted with the pet robot MiRo and when they considered that companion pet robots could also be undertaking practical functions, such as healthcare-related functions.

This programme of research employed a mixed methods approach, including both qualitative and quantitative research methods. Individual and group interviews were used in the programme of research as qualitative methods, which provide rich, descriptive data that captures the complexity and context of participants' perceptions about technology and robots. A questionnaire was also used in the programme of research as a quantitative method, which measured and quantified variables using statistical analysis. The questionnaire also led to a new concise model that can be used to investigate older people's attitudes toward robots. In addition, the questionnaire could assist in studying older people's attitudes toward robots, provide quantitative data on multiple dimensions, and can complement qualitative data from methods such as interviews. In addition, this programme of research employed multiple methods to present information to participants to help them understand robots and explore their attitudes toward them, such as providing descriptions, watching videos and interacting with robots. Interestingly, different methods yielded different results, which could provide useful information for designing future studies to investigates the attitudes of older people towards technology and robots.

Taken as a whole, the programme of research contributes to our understanding of young Chinese technologists' attitudes towards older people as technology users, which will lead to research and educational efforts to try to arouse young technologists' awareness that older people are important users of technology. In addition, this study provides a understanding of the current use of technology in daily life by older Chinese people and their attitudes towards these technologies. This should help technology developers design technology that match older Chinese people's use and meets their needs. In addition, this study confirms that older Chinese people have a positive attitude towards new technologies and robots, which also shows that it is feasible to use technology and robots to assist and care for older Chinese people in the future. Finally, this programme of research has provided a deeper insight into the attitudes of older Chinese people towards different types of robots, which will help in the future design of robots that are acceptable to older Chinese people and meet their expectations.

To better design technologies and robots that meet the needs of older Chinese people and improve their experience of using them, future research should focus on how to help young Chinese technologists with age-related biases and the significance of designing with careful consideration for older users. In addition, further studies should be conducted in older Chinese people's homes to see their actual use and long term attitudes toward robots.

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Appendix A: Informed consent form for Study 1 (Ageism and sexism amongst young technologists and older people)

a) Informed consent form in English

Study on technology use and expertise

Thank you for offering to take part in this study.

It will only take you a couple of minutes of your time. It involves looking at a photo of a person and answering a short set of questions about what you think the computer experience and expertise of the person. The information you provide is completely confidential and anonymous. You will not be asked for any information that will identify you.

You may withdraw from the study at any point. At the beginning of the study you will be given a unique code. If you wish to withdraw and have your information deleted, you can email me with the code and I will delete your information.

If you have any questions please email me, Yao Chen at yc2046@york.ac.uk or my supervisor Professor Helen Petrie at helen.petrie@york.ac.uk.

I have read and understood the above and consent to participate in this study.

Yes

No

b) Informed consent form in Chinese

关于数码产品的使用和技能的研究

感谢您参与这项调研。

这项调研只需花费您几分钟的时间。其中包括观察一个人的照片和回答一系列简短的关于您认为这个人的电脑使用经验和技能的问题。在这项调研中您提供的信息是完全保密和匿名的，并且不会要求您提供任何可以识别您身份的信息。

你可以在任何时候退出此项研究。在研究开始的时候，我们将给您一个编号。如果您想要退这项研究出并删除关于您的信息，可以将您的编号告知我们，我们将删除关于您在这项研究中的信息。如果您有任何疑问，请给我发送电子邮件（yc2046@york.ac.uk）或給我的导师 Helen Petrie 教授发送电子邮件（helen.petrie@york.ac.uk）。

我已阅读并理解上述内容，并同意参与本研究。

是

否

Appendix B: Study 1 (Ageism and sexism amongst young technologists and older people) questionnaire

a) Questionnaire in English

PHOTO (one of the photos in the attached sheet)

How old do you think this person is? ___________________________________

Would you call this person old? Yes / No

What's the minimum age you would think of someone as old? ________________

How likely do you think it is that this person uses a desktop computer regularly?

(circle one of the crosses to give your answer)

Very unlikely + --------- + --------- + --------- + --------- + --------- + --------- + Very likely

How likely do you think it is that this person uses a laptop computer regularly?

Very unlikely + --------- + --------- + --------- + --------- + --------- + --------- + Very likely

How likely do you think it is that this person uses a smartphone regularly?

Very unlikely + --------- + --------- + --------- + --------- + --------- + --------- + Very likely

How expert do you think this person would be with a desktop computer?

Not at all + --------- + --------- + --------- + --------- + --------- + --------- + Very expert

How expert do you think this person would be with a laptop computer?

Not at all + --------- + --------- + --------- + --------- + --------- + --------- + Very expert

How expert do you think this person would be with a smartphone?

Not at all + --------- + --------- + --------- + --------- + --------- + --------- + Very expert

Your age:

Your gender: M / F / other

Your profession:

If you are a student, what is your major subject of study:

b) Questionnaire in Chinese

照片（附件中的其中一张照片）

您认为此人的年纪是多少?

在您看来她是否可以称之为老年人?　　是 / 否

您认为作为老年人的最小年纪应该是多少?

您认为此人经常使用台式计算机的可能性有多大?

（在其中一个“+”上圈出你的答案）

不太可能 + --------- + --------- + --------- + --------- + --------- + --------- + 极有可能

您认为此人经常使用笔记本电脑的可能性有多大?

不太可能 + --------- + --------- + --------- + --------- + --------- + --------- + 极有可能

您认为此人经常使用智能手机的可能性有多大?

不太可能 + --------- + --------- + --------- + --------- + --------- + --------- + 极有可能

您认为此人能熟练使用台式电脑的程度有多高?

一点都不 + --------- + --------- + --------- + --------- + --------- + --------- + 非常熟练

您认为此人能熟练使用笔记本电脑的程度有多高?

一点都不 + --------- + --------- + --------- + --------- + --------- + --------- + 非常熟练

您认为此人能熟练使用智能手机的程度有多高?

一点都不 + --------- + --------- + --------- + --------- + --------- + --------- + 非常熟练

您的年龄:

您的性别: 女性 / 男性 / 其他

您的职业:

如果您是学生，您的所学的专业是什么:

Appendix C: Informed consent form for Study 2 (Investigation of older Chinese people's use and attitudes to digital technologies and robots)

a) Informed consent form in English

Study on use and attitudes of technology and robots

Thank you for offering to take part in this study.
The study will be conducted by online interview, and it will take you half an hour of your time. The researcher will ask you questions on three different topics: your use and attitudes towards technology; how your use of technology was changed during the Coronavirus period and your opinions of this change; your knowledge and expectations about using robots. The interview process will be audio recorded but will only be listened to by the researcher who interviews you, so they do not have to take notes during the interview. The information you provide is completely confidential and anonymous. You will not be asked for any information that will identify you individually.
You may withdraw from the study at any point. At the beginning of the interview you will be given a unique code. If you wish to withdraw and have your information deleted, you can email me with the code and I will delete all your information.

If you have any questions please email me, Yao Chen at yc2046@york.ac.uk or my supervisor Professor Helen Petrie at helen.petrie@york.ac.uk.

I have read and understood the above and consent to participate in this study.
Signature:
Date:

b) Informed consent form in Chinese

关于对科技产品和机器人的态度和使用的研究

感谢您参加本次调研。
该项调研将通过在线访谈的方式进行，将花费您半小时左右的时间。研究人员将针对三个主题向您提出问题：您对科技类产品的使用和态度；在新型冠状病毒期间，您对科技产品的使用有何变化以及您对此变化的看法；您对使用机器人有多少了解和您对使用机器人的期望。访谈过程将会被录音，但只会由采访您的研究人员收听，所以他们不会在采访过程中做笔记。您提供的信息是完全保密和匿名的。你不会被要求提供任何能识别你个人身份的信息。
你可以在任何时候退出此项调研。在调研开始的时候，我们将给您一个编号。如果您想要退这项调研出并删除关于您的信息，可以将您的编号告知我们，我们将删除关于您在这项调研中的信息。
如果您有任何疑问，请给我发送电子邮件（yc2046@york.ac.uk）或給我的导师 Helen Petrie 教授发送电子邮件（helen.petrie@york.ac.uk）。

我已阅读并理解上述内容，并同意参与此次调研。
签名：
日期：

Appendix D: Study 2 (Investigation of older Chinese people's use and attitudes to digital technologies and robots) interview questions

a) Study 2 interview questions in English

Living Arrangement and Daily Life

1. Where do you live？ [big city/apt, etc]

1） How big is the city/town/village?

2） Is this your home town?

3） If not, how often do your visit your home town?

2. Who lives with you？ [family, pets]

1）What about your "extended" family, are they close by?

3. How has your day been today?

4. Was it very different during lockdown? （Compare life before lockdown and after lockdown）

Technology

1. Before lockdown what technology products did you use in daily life?

2. What did you use of these technology products for? [repeat for different technologies]

1) What is/was good about X

2) What is/was difficult about X

3) [If relevant: Do you have privacy/security/other concerns about X?]

4) What was easy or difficult to learn how to use X

5) How did you learn how to use X?

[if they don't mention smartphone, computer, tablets, prompt them to answer about these]

3. When new technology products come out, do you think you're going to use them？

1) Where do you find about new technology products?

4. How do you decide whether to use new products or not?

5. What is your attitude towards new technology products in general？

1 = not interested at all to 7 =very interested

Coronavirus (lockdown change)

1. Did you use more technology products (than usual during this period）?

2. What did you use more

[if they don’t mention smartphone, computer, tablets, ask about these]

For each technology mentioned:

3. What did you use X for?

[Prompts: staying in contact with family and friends, entertain, shopping, deliveries, medical care,

medicines]

4. Did you rely more on these X than usual?

5. How frequently did you use X [in terms of days, amount of time per day]？

[After going through specific technologies, more general questions:]

6. What were the positives and negatives of using technology (more) during lockdown？

7. Did technology help you maintain social relations with family and friend when you were at home during lockdown?

8. What kinds of things would help people of your age or older stay social (particularly with family and friends) during this period and in the future?

9. Did you feel lonely before lockdown and what about during lockdown？

1) If yes to loneliness, what things did you do or would to have done to combat loneliness?

2) If no, what kinds of things would help people of your age or older who might have been lonely during lockdown or in general

10. Did you feel bored before lockdown and what about during lockdown (After Retirement)?

11. Is there any way to solve the problem of boredom?

11. Did you use technology to entertain yourself during lockdown?

12. Did you learn any new skills (particularly with technology) during lockdown？

Robots

1. Do you know that robots can help older people at home?

1) If yes, what do you think robots are used for in the home and where did you find out about this?

2) If no, explain about robots at home

[pictures of different robots shown here – explanation of social and task-oriented robots]

2. If you had a robot, what would you like it to for you? [don't think about what is possible, what they would like]

[Prompts: social or tasks? or both?]

3. Would you feel comfortable or uncomfortable about having a robot in your home? [Robots in the same room with you?]

4. Would you be willing to have robots help you in the home?

1) If yes, what with? [social or tasks or both]

2) If no, why not?

5. Do you think you will use them in the future？

[Prompt: particularly as you get older, {if you were alone}]

1) If so, what for? [social, task ..]

6. Do you have any concerns of having robots help you in the home?

1） If so, what concerns?

Gender:

Age:

Job before retirement:

How long retired:

b) Study 2 interview questions in Chinese

日常生活

1. 你住在哪里？[大城市/公寓等]

1) 这个城市/镇/村有多大?

2) 这是你的家乡吗?

3) 否--你多久去一次你的家乡?

2. 谁和你住在一起？[家庭，宠物]

1） 你的大家庭怎么样，他们住在附近吗?

3. 今天过得怎么样？

4. 在封城期间，你的生活有很大的不同吗（比较封城前和封城后的生活）？

科技产品

1. 在封城之前，你在日常生活中使用哪些科技产品?

2. 你用这些科技产品是做什么? [重复参与者刚刚提到的科技产品]

1) X 产品的好处是什么？

2) X 的坏处是什么？

3) [如果相关: 您对 X 有隐私/安全/其他担忧吗?]

4) 学习如何使用 X 困难吗，还是容易？

5) 你是如何学习怎样去使用 X？

【如果他们没有提到智能手机、电脑、平板电脑，就提醒他们回答这些问题】

3. 当新科技产品问世的时候，你认为你将会去使用它们吗?

1) 你是从哪里得知新的科技产品的？

4. 你是如何决定是否要使用新的科技产品的？

5. 总的来说，你对新的科技产品的态度是什么?

1 = 完全不感兴趣 7 = 非常感兴趣

新型冠状病毒（封城期间的变化）

1. 在此期间，你是否比平时更多的使用了科技产品?

2. 您用的更多的是哪一种产品?

【如果他们没有提到智能手机、电脑、平板电脑，就提醒他们回答这些问题】

对于上述每种技术:

3. 用 X 来做什么呢?

4. 您在封城期间，是否比平时更依赖 X?

【提示：与家人和朋友保持联系，娱乐，购物，送货，医疗保健，药品】

5. 您使用 X 的频率是多少? [每天大概会使用多少次]?

【结束了询问具体的科技产品之后，询问对于整个科技产品大类的看法:】

6. 在封城期间，(更多地)使用数码科技产品的积极（好的方面）和消极之处（不好的方面）是什么，在这期间?

7. 科技是否帮助你维持了与家人和朋友的社会关系，当封城在家的时候?

8. 怎么样可以帮助你的同龄人保持社交(特别是与家人和朋友)，在这个时期或者将来?

9. 你会感觉到孤单吗？在封城之前，和封城的这段时间?

1) 是--你有没有做些什么或者有些什么方法来让自己感到不孤单?

2) 否--你觉得有什么方法可以帮助你的同龄人或年纪更大一些的老年人不感到孤独?

10. 你在封城之前会常常感觉到无聊（无所事事）吗？和封城期间呢？ （退休之后）

11. 有什么办法解决无聊（无所事事）的问题吗?

12. 在封城期间，你会通过使用科技产品老达到娱乐的目的吗?

12. 在封城期间，你学到了什么新技能(尤其是使用科技产品)吗?

机器人

1. 你知道机器人可以在家里帮助老年人吗?

1) 是--你认为机器人在家里是用来做什么的? 你从哪里得知的?

2) 否--向参与者解释机器人的功能等。

[这里展示的不同机器人的图片 - 解释社交型和任务型机器人]

2. 如果你有一个机器人，你希望它为你做什么? [不要去想什么是可能的，他们想要什么]

【提示: 社交 或 任务？或两者都?】

3. 如果家里有个机器人，你会觉得舒服还是不舒服? [机器人和你在同一个房间]

4. 你愿意家里有一个机器人去给你提供帮助吗？

1) 是--做些什么? [社交 或 任务 或 两者]

2) 否--为什么不愿意?

5. 你认为你会在将来去使用它们吗?

【提示: 特别是当你年纪大了之后，{如果你是一个人生活的话}】

1) 是--希望它们做些什么 [社交, 任务 ..]

6. 你对让机器人在家里帮助你有些什么顾虑吗?

2) 有--有哪些顾虑?

性别:

年龄:

退休前的工作:

退休多久了:

Appendix E: Study 3 (Investigation of older Chinese people's attitudes and preferences for different robot types) interview structure and questions

a) Interview structure and questions in English

Interview information and instructions:

Thank you for offering to take part in this study.

The study will take about 20 minutes of your time. The researcher will play three videos of different types of robots. After watching each video, the researcher will ask you some questions about your attitudes and preferences for the robots in the video.

The interview process will be audio recorded but will only be listened to by the researcher who interviews you, so they do not have to take notes during the interview. The information you provide is completely confidential and anonymous. You will not be asked for any information that will identify you individually.

You may withdraw from the study at any point. At the beginning of the interview you will be given a code. If you wish to withdraw and have your information deleted, you can email me with the code and I will delete all your information.

If you have any questions please email me, Yao Chen at yc2046@york.ac.uk or my supervisor Professor Helen Petrie at helen.petrie@york.ac.uk.

Finally, I just want to check that you are happy to be involved in this research, everything would be anonymous and confidential, is that okay?

Introduction/Warm Up

1. How has your day been today?

2. Who lives with you？ [family, others, pets]

3. Do you know that robots can help older people at home?

4. Have you ever seen/used robots?

5. if you don’t mind me asking/I don’t want to be rude, but for the research I need to ask your age, gender]

Companion pet robots:

[Show participants video]

1. Would you be happy to have one of these pet robots?

2. What would you like to do with it?

3. Which one would you prefer most? And why?

4. Which one would you prefer least? And why?

5. So – x is in the middle, is that OK? What are your thoughts about that one?

Table robots:

[Show participants video]

1. Would you be happy to have one of these table robots?

2. What would you like to do with it?

3. Which one would you prefer most? And why?

4. Which one would you prefer least? And why?

5. So – x is in the middle, is that OK? What are your thoughts about that one?

Movement robots:

[Show participants video]

1. Would you be happy to have one of these movement robots?

2. What would you like to do with it?

3. Which one would you prefer most? And why?

4. Which one would you prefer least? And why?

5. So – x is in the middle, is that OK? What are your thoughts about that one?

1. Which types of robot would you prefer most? (pets/table/movement) And why?

[If participants don’t remember what types of robots there are, reminder them or play the video again.]

2. Which types of robot would you prefer least? And why?

3. So – x is in the middle, is that OK? What are your thoughts about that one?

4. In general, what would you want that robots can do for you?

Thank you for taking part in this study. Is there anything you want to add, or do you have any questions you want to ask me?

b) Interview structure and questions in Chinese

采访信息和简介:

感谢您参与这项研究。

这项研究将占用您大约 20 分钟的时间。研究员将播放三段不同类型机器人的视频。在观看完每个视频后，研究人员会问您一些关于您对视频中的机器人的态度和喜好的问题。

采访过程将会录音，但只会被采访您的研究员听到，所以研究员在采访过程中不会做笔记。您提供的信息是完全保密和匿名的。您不会被要求提供任何会能够识别您身份的信息。

您可以在任何时候退出这项研究。在面试开始时，你会得到一个代码。如果您想撤回并删除您在这项研究中所提供的信息，你可以发邮件告诉我您的代码，我将删除您在这项研究中所有的信息。

如果您有任何问题，请给我发送邮件，yc2046@york.ac。或者我的导师 Helen Petrie 教授发送邮件，helen.petrie@york.ac.uk

最后，我想确认一下你是否乐意参与这项研究，您所提供的一切信息都是匿名的和保密的，可以吗?

介绍 / 寒暄

1. 你今天过得怎么样?

2. 你和谁生活在一起?(家人、他人、宠物)

3. 你知道机器人可以在家里帮助老年人吗?

4. 你见过/使用过机器人吗?

5. 如果您不介意我问/我不想太无礼，但为了研究我需要问一下您的年龄和性别]

陪伴型宠物机器人:

「给参与者播放视频」

1. 您愿意拥有一个这样的宠物机器人吗?

2. 您会想要和它一起做些什么呢?

3. 您最喜欢哪一个? 为什么?

4. 您最不喜欢哪一个? 为什么?

5. X 在中间，对吗? 您对这个宠物机器人有什么看法?

小型功能型台式机器人:

「给参与者播放视频」

1. 您愿意拥有一个这样的台式机器人吗?

2. 您会想要和它一起做些什么呢?

3. 您最喜欢哪一个? 为什么?

4. 您最不喜欢哪一个? 为什么?

5. X 在中间，对吗? 您对这个台式机器人有什么看法?

大型可移动型机器人

「给参与者播放视频」

1. 您愿意拥有一个这样的可移动型机器人吗?

2. 您会想要和它一起做些什么呢?

3. 您最喜欢哪一个? 为什么?

4. 您最不喜欢哪一个? 为什么?

Appendix F. Informed consent form for Study 4 (MiRo - Attitudes and expectations of a pet robot for older Chinese people for companionship and assistance)

a) Informed consent form in English

Information sheet

Thank you for offering to take part in this study which is about how robots can help older people

live independently.

The study will take 30 minutes of your time. The researcher will show a small robot called MiRo

which is a bit like a pet. Then, the researcher will do three different things with MiRo, and you try

the same things with MiRo and see what it is like. After that, the researcher will play a video which

shows some other things that MiRo could do for you. Finally, you will be asked to complete a

questionnaire about what you think about companion robots and answer some questions about

what you thought of MiRo.

Our discussion will be audio recorded but only I will listen to it, so I do not have to take notes while

we are talking. The information you provide is completely confidential and anonymous. You will

not be asked for any information that will identify you individually.

You may withdraw from the study at any point. At the beginning of the interview you will be given

a unique code. If you wish to withdraw and have your information deleted, you can email me with

the code and I will delete all your information.

If you have any questions please email me, Yao Chen at yc2046@york.ac.uk or my supervisor

Professor Helen Petrie at helen.petrie@york.ac.uk.

Finally, I just want to check that you are happy to be involved in this research, everything would be

anonymous and confidential, is that okay?

b) Informed consent form in Chinese

调研简介

感谢您愿意参与这项关于机器人如何帮助老年人独立生活的研究。

该研究将占用您 30 分钟的时间。研究人员将展示一个名为 MiRo (米罗)的小型机器人,它有点像宠物。然后,研究人员会用 MiRo(米罗)做三件不同的事情;之后你可以用 MiRo(米罗)尝试同样的事情,看看它是什么样的。之后,研究人员将播放一段视频,展示 MiRo(米罗)可以为您做的其他事情。最后,您将被要求完成一份关于您对伴侣机器人的看法的问卷,并回答一些关于您对 MiRo (米罗)的看法的问题。

我们的讨论将被录音,但只有我会听,所以我们谈话时不必做笔记。您提供的信息是完全保密和匿名的。您不会被要求提供任何可以识别您个人身份的信息。

您可以随时退出研究。在面试开始时,您将获得一个唯一代码。如果您想退出并删除您的信息,您可以通过电子邮件将代码发送给我,我将删除您的所有信息。

如果您有任何问题,请发送电子邮件至我的邮箱 yc2046@york.ac.uk,或给我的导师 HelenPetrie 教授发送电子邮件至 helen.petrie@york.ac.uk。

最后,我只是想确认一下您是否乐意参与这项研究,一切都是匿名和保密的,可以吗?

Appendix G. Study 4 (MiRo - Attitudes and expectations of a pet robot for older Chinese people for companionship and assistance) interview questions

a) Interview questions in English

Semi-structured interview about MiRo and companion robots

1. What do you think it is? Which kind of animal?

2. Do you think it's a boy or girl?

3. What would you like MiRo to do?

[this question is to get a general first idea of what they want from a robot and whether it's social or task-oriented functions; we can analyse their answers first into these two categories and then into more specific types of functions]

4. Would you like it to be a companion?

5. Would you want talk with MiRo?

[If they answer yes or possibly – what would you like to talk to MiRo about? / would you like MiRo to give you advice? If yes or possibly, what kind of advice? Advice on what topics?]

6. Would you like to play games with MiRo?

7. [If they answer yes or possibly – what kinds of games would you like to play with MiRo?]

8. Are there other things you would like to do with MiRo?

[questions 4 to 7 are about MiRo as a social robot]

9. What things could MiRo do for you around the house?

[this is asking about the task-oriented functions]

[Prompts: Security, health, monitoring]

Could MiRo help you with looking after your health, such as monitoring blood pressure?

Could MiRo remind you take your medicine?

Could MiRo check that you have locked the door, closed all the windows before you go to bed?

10. Would you be happy to have Miro in your house?

11. Would you have any worries about having MiRo or a robot like this this in your house?

12. (How much that you would pay for it?)

b) Interview questions in Chinese

采访问题

1. 你认为米罗是什么? 哪种动物?

2.你觉得米罗是男孩还是女孩?

3. 你希望米罗做什么?

[这个问题是为了大致了解他们想要从机器人那里得到什么,以及它是社交功能还是任务导向功能;我们可以先把他们的答案分析成这两个类别,然后再分析更具体的功能类型]

4.你愿意它做伴吗?

5. 你想和米罗聊天吗?

[如果他们回答"是"或"可能" - 你想和 MiRo (米罗)聊些什么? / 你想让 MiRo 给你建议吗?如果"是"或"可能",什么样的建议?关于什么主题的建议?]

6.你想和 MiRo(米罗)玩游戏吗?

7. [如果他们回答是或可能 - 你想和 MiRo (米罗)玩什么类型的游戏?]

8. 你还有什么想用 MiRo (米罗)做的事吗?

【问题 4 到 7 是关于 MiRo(米罗)作为社交机器人的问题】

9. MiRo (米罗)能为您在家里做些什么?

[这是关于面向任务的功能]

【提示:安全、健康、监控】

MiRo (米罗)可以帮助您照顾您的健康,例如监测血压吗?

MiRo (米罗)能提醒你吃药吗?

MiRo (米罗)能否在您睡觉前检查您是否已锁门、是否关闭所有窗户?

10. 家里有米罗你会开心吗?

11. 你家有 MiRo(米罗) 或这样的机器人, 你会担心吗?

12.(你愿意这台机器人支付多少钱?)

Appendix H. The Almere model questionnaire was used in Study 4 (MiRo - Attitudes and expectations of a pet robot for older Chinese people for companionship and assistance)

a) The Almere model questionnaire in English

Please rate your level of agreement with each statement:

1. Totally agree
2. Agree
3. Don’t know
4. Do not agree
5. Totally do not agree

[ANX Anxiety]

If I were to use the robot, I would be afraid to make mistakes with it

If I were to use the robot, I would be afraid to break something

I find the robot scary

I find the robot intimidating

[ATT Attitude towards technology]

I think it would be a good idea to use the robot

The robot would make life more interesting

It’s good to make use of the robot

[FC Facilitating conditions]

I have everything I need to use the robot

I know enough about the robot to make good use of it

[ITU Intention to Use]

I think I would use the robot

I'm certain I would use the robot

I plan to use the robot

[PAD Perceived adaptiveness]

I think the robot could be adapted to what I need

I think the robot would only do what I need at any particular moment

I think the robot would help me when I considered it to be necessary

[PENJ Perceived Enjoyment]

I would enjoy the robot talking to me

I would enjoy doing things with the robot

I think I would find the robot enjoyable

I find the robot fascinating

I find the robot boring

[PEOU Perceived Ease of Use]

I think I would know quickly how to use the robot

I think I would find the robot easy to use

I think I could use the robot without any help

I think I could use the robot only when there is someone around to help me

I think I could use the robot if I have a good manual

[PS Perceived Sociability]

I think I would consider the robot a pleasant partner

I find the robot pleasant to interact with

I feel the robot understands me

I think the robot is nice

[PU Perceived Usefulness]

I think the robot would be useful to me

It would be convenient for me to have the robot

I think the robot could help me with many things

[SI Social Influence]

I think the others would like me using the robot

I think it would give a good impression if I were to use the robot

[SP Social Presence]

When interacting with the robot I felt like I’m talking to a real pets

It sometimes felt as if the robot was really looking at me

I can imagine the robot to be a living creature

I often think the robot is not a real pets

Sometimes the robot seems to have real feelings

Information to note about the participant:

Age:

Gender:

Unique code:

b) The Almere model questionnaire in Chinese

在接触完米罗后， 请根据您的实际感受选择符合的项，将编号填在横线上

1 完全同意

2 同意

3 说不准

4 不同意

5 完全不同意

【焦虑】

如果我要使用此机器人，我会害怕弄错

如果我要使用此机器人，我会害怕弄坏东西

我觉得机器人很可怕 （我害怕机器人）

我觉得机器人很吓人 （我被机器人吓到了）

【对技术的态度】

我觉得使用机器人是个好主意

机器人会让生活更有趣

使用机器人很好

【促成条件】

我拥有使用机器人所需的一切

我对机器人足够了解，可以很好地利用它

【使用意向】

我会在接下来的一段时间内使用机器人

我肯定会在接下来的一段时间内使用机器人

我打算在接下来的一段时间内使用机器人

【感知适应能力】

我觉得机器人可以适应我的需求

我觉得机器人只会在那个特定的时刻做我需要的事情

我觉得机器人会在我认为必要时帮助我

【感知愉悦性】

我喜欢机器人跟我说话

我喜欢和机器人一起做事

我觉得机器人很有趣

我觉得机器人很迷人

我觉得机器人很无聊

【感知易用性】

我觉得我会很快知道如何使用机器人

我觉得这个机器人是很容易使用的

我觉得我可以在没有任何帮助的情况下使用机器人

我觉得我可以在有人帮助我的情况下使用机器人

我觉得我可以在有一本好的使用说明书的情况下使用机器人

【感知社交能力】

我觉得机器人是一个愉快的伙伴

我觉得与机器人互动很愉快

我觉得机器人可以理解我

我觉得机器人很不错

【感知有用性】

我觉得机器人对我有用

有机器人对我来说会很方便

我觉得机器人可以帮助我做很多事情

【社会影响】

我觉得人们会希望我使用机器人

我觉得如果我使用机器人会给人留下很好的印象

【社会存在感】

与机器人互动时，我觉得就像在与真的动物交谈

有时我觉得机器人好像真的在看着我

我可以把机器人想象成一个有生命的生物

我经常觉得机器人不是一个真实的动物

有时机器人似乎有真实的感觉

您的年龄:

您的性别:

您的编号:

Appendix I. The Almere model questionnaire

ANX - Anxiety	If I should use the robot, I would be afraid to make mistakes with it If I should use the robot, I would be afraid to break something I find the robot scary I find the robot intimidating
ATT - Attitude toward technology	I think it's a good idea to use the robot The robot would make life more interesting It's good to make use of the robot
FC – Facilitating conditions	I have everything I need to use the robot I know enough of the robot to make good use of it
ITU - Intention to Use	I think I'll use the robot during the next few days I'm certain to use the robot during the next few days I plan to use the robot during the next few days
PAD - Perceived adaptiveness3	I think the robot would be adaptive to what I need I think the robot will only do what I need at that particular moment I think the robot will help me when I consider it to be necessary
PENJ - Perceived Enjoyment	I enjoy the robot talking to me I enjoy doing things with the robot I find the robot fascinating I find the robot boring I find the robot enjoyable
PEOU - Perceived Ease of Use	I think I will know quickly how to use the robot I find the robot easy to use

	I think I can use the robot without any help I think I can use the robot when there is someone around to help me I think I can use the robot when I have a good manual
PS - Perceived Sociability	I consider the robot a pleasant conversational partner I find the robot pleasant to interact with I feel the robot understands me I think the robot is nice
PU - Perceived Usefulness	I think the robot is useful to me It would be convenient for me to have the robot I think the robot can help me with many things
SI - Social Influence	I think the staff would like me using the robot I think it would give a good impression if I should use the robot
SP - Social Presence	When interacting with the robot I feel like I'm talking to a real person Sometimes the robot seems to have real feelings I often think the robot is not a real person It would feel as if the robot is really looking at me I can imagine the robot to be a living creature
Trust - Trust	I would trust the [name] robot if it gave me advice I would follow the advice the [name] robot gives me

Appendix J. Comparing of the Almere model questionnaire and the Almere Model Questionnaire as adapted for this study

ANX - Anxiety	If I should use the robot, I would be afraid to make mistakes with it If I should use the robot, I would be afraid to break something I find the robot scary I find the robot intimidating	If I should use the robot, I would be afraid to make mistakes with it If I should use the robot, I would be afraid to break something I find the robot scary I find the robot intimidating
ATT - Attitude toward technology	I think it's a good idea to use the robot The robot would make life more interesting It's good to make use of the robot	I think it's a good idea to use the robot The robot would make life more interesting It's good to make use of the robot
FC – Facilitating conditions	I have everything I need to use the robot I know enough of the robot to make good use of it	I have everything I need to use the robot I know enough of the robot to make good use of it
ITU - Intention to Use	I think I'll use the robot during the next few days I'm certain to use the robot during the next few days I plan to use the robot during the next few days	I think I'll use the robot during the next few days I'm certain to use the robot during the next few days I plan to use the robot during the next few days
PAD - Perceived adaptiveness	I think the robot would be adaptive to what I need I think the robot will only do what I need at that particular moment I think the robot will help me when I consider it to be necessary	I think the robot can be adaptive to what I need I think the robot will only do what I need at that particular moment I think the robot will help me when I consider it to be necessary
PENJ - Perceived Enjoyment	I enjoy the robot talking to me I enjoy doing things with the robot	I enjoy the robot talking to me I enjoy doing things with the robot

	I find the robot fascinating I find the robot boring I find the robot enjoyable	I find the robot enjoyable I find the robot fascinating I find the robot boring
PEOU - Perceived Ease of Use	I think I will know quickly how to use the robot I find the robot easy to use I think I can use the robot without any help I think I can use the robot when there is someone around to help me I think I can use the robot when I have a good manual	I think I will know quickly how to use the robot I find the robot easy to use I think I can use the robot without any help I think I can use the robot when there is someone around to help me I think I can use the robot when I have a good manual
PS - Perceived Sociability	I consider the robot a pleasant conversational partner I find the robot pleasant to interact with I feel the robot understands me I think the robot is nice	I consider the robot a pleasant partner I find the robot pleasant to interact with I feel the robot understands me I think the robot is nice
PU - Perceived Usefulness	I think the robot is useful to me It would be convenient for me to have the robot I think the robot can help me with many things	I think the robot is useful to me It would be convenient for me to have the robot I think the robot can help me with many things
SI - Social Influence	I think the staff would like me using the robot I think it would give a good impression if I should use the robot	I think the others would like me using the robot I think it would give a good impression if I should use the robot
SP - Social Presence	When interacting with the robot I feel like I'm talking to a real person Sometimes the robot seems to have real feelings I often think the robot is not a real person	When interacting with the robot I felt like I'm talking to a real pet It sometimes felt as if the robot was really looking at me I can imagine the robot to be a living creature

	It would feel as if the robot is really looking at me I can imagine the robot to be a living creature	I often think the robot is not a real pet Sometimes the robot seems to have real feelings
Trust - Trust	I would trust the [name] robot if it gave me advice I would follow the advice the [name] robot gives me	