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Touchscreen Mobile Devices and Older Adults: A Usability Study

Tom Page

Electronic Product Design, Loughborough Design School, LDS.1.18, Loughborough University, LE11 3TU, UK. E-mail: T.Page@lboro.ac.uk

Biography

Tom's background is in electro-optics development and production and worked for Ferranti Defence Systems Ltd. in Edinburgh. In 1990, he took up a two-year fixed-term research assistantship at the Engineering Design Research Centre in Glasgow. Upon completion of this role, he taught Computer-Aided Engineering at the University of Hertfordshire in Hatfield. Since moving to Loughborough University in 2003, Tom has taught electronic product design, interaction design, design and manufacturing technology and physical computing. His research interests are in engineering design, value management, technology education and electronic product design.

ABSTRACT

The increasing advance and use of technology presents challenges for older users and older generations often experience difficulty in using new technology compared with their younger counterparts. The purpose of this work was to investigate how touchscreen devices have affected the usability of interactive consumer products by older adults. This work was conducted with older adults to explore their perceptions of touchscreen interfaces and to understand existing usability issues and barriers to their adoption. The research was conducted with four participants and each was required to carry out common tasks on mobile phones which they were unfamiliar with. It was seen that some older users are frequent users of modern technologies such as touchscreens and find this easier to use than systems which are generally perceived as more 'simple' systems such as keypads on a mobile phone. Technological advances show a change in interface design, making use easier for all users, in particular older people, yet this has not been developed to its full potential and still deters certain users from choosing to use products implementing these technologies. It is recommended that technology developers consider the needs and desires of older adults as a user group.

Keywords touchscreen devices, usability, older adults

INTRODUCTION

The increasing advance and use of technology along with a ageing population present challenges for older users (Eisma, Dickinson, Goodman, Syme, Tiwari & Newell, 2004). Older generations experience difficulty in using new technology compared with their younger counterparts (Czaja, & Lee, 2007; Charness, & Boot, 2009). The purpose of this work was to investigate how touchscreen devices have affected the usability of interactive consumer products by older adults. In order to fulfil this purpose, a review of literature was undertaken in order to recognise how touchscreen interfaces have changed in recent years. Furthermore, primary research was conducted with older adults to explore their perceptions of touchscreen interfaces and to understand existing usability issues and barriers to their adoption.

LITERATURE REVIEW

There are three types of touchscreen technologies: resistive; surface wave; and capacitive. Resistive touchscreens are most popular used in the mobile phone industry and are formed of thinly separated multiple membranes. When pressure is applied by a finger or stylus, the layers compress and complete electrical connections, the device recognises the area being touched, allowing the action to be completed. For example, the HTC Touch Diamond mobile phone uses resistive technology. Surface wave technology uses ultrasonic waves that pass over the screen panel and works by a portion of the waves being absorbed when the screen is touched. This area causes a wave distortion and sends information to the processor. Due to the high impact resistance of this type of touchscreen it is widely selected for use in public information kiosks and ATM machines. Capacitive touchscreen panels are coated with a material that stores electrical charges. When the panel is touched, a small amount of the charge is drawn towards the point of contact; the charge is measured and then processed. Capacitive touchscreens are only sensitive to being touched by a finger unlike resistive touchscreens. Products such as the Apple iPhone use this type of touchscreen technology (Bhalla & Bhalla, 2010).

Studies of technology use, attitudes and abilities of technology use do show that older adults are less likely to use technology compared with younger adults (Czaja, Charness, Fisk, Hertzog, Nair, Rogers, & Sharit, 2006). However, the assumption that older adults wish to avoid using new technology is a large misconception. Older user's relationships with technology have customarily been pessimistically portrayed, yet evidence suggests that older users desire interaction with new technologies in order to remain active and engaged with society (Kurniawan, 2008). Such research shows that older adults do want to use emerging technologies, and feel that by doing so they are still remaining integrated within modern society which indicated that this is an important factor to them. Education is a crucial factor that has a significant effect on older adult's performance when interacting with technology. Nevertheless, it is important to consider that older adults have expressed their interest in using modern devices however, feel that modern technology is not suitably designed for their abilities (Goddard & Nicolle, 2012).

Holzinger, Searle & Wernbacher (2011) described some usability metrics ascertained on the basis of experiments made with applications for elderly people throughout the summer term of 2007. The factors that influence the older users' acceptance of software, including the extent of their previous exposure to technology, were evaluated in order to provide short guidelines for software developers on how to design and develop software for the elderly. The evaluation of the expectations, behaviour, abilities, and limitations of prospective end-users was considered of primary importance for the development of technology.

Holzinger, Searle, & Nischelwitzer, (2007) summarised some relevant issues in order to devise a research methodology to cover more than just the technological and physical aspects of user interfacing but also psychological and sociological aspects. One aspect of achieving this aim was to confront designers and developers with those problems that the elderly face daily and which are not easily understood – especially by younger designers and developers. Holzinger, Mukasa & Nischelwitzer (2008) considered multimodal user interfaces combining various input and output modalities (including seeing/vision, hearing/audition, haptic/tactile, taste/gustation, smell/olfaction etc) which are classical research areas in Human-Computer Interaction (HCI) and Usability Engineering (UE). One of the advantages of multiple modalities is increased usability: the weaknesses of one modality are offset by the strengths of another.

Holzinger, Searle, Auinger & Ziefle (2011) reported on our experiences in design, development and evaluation of computer applications in the area of ambient assisted living for elderly people, where engineers highly underestimate the power of appropriate knowledge on semiotics and we demonstrate how we can emphasize universal access by thinking of informatics as semiotics engineering. A shifting age ratio combined with the spread of the internet means that the importance of interfaces for older users has increased considerably (Rau and Hsu, 2002). A conscious effort to make interfaces more practical for older users is apparent. For instance, forms of tactile feedback given when interacting with a product, such as audio and haptic feedback. This type of feedback can be useful for older users as it gives the user a response whilst interacting with a product. This literature review suggests that the majority of emerging technologies are designed with the younger population in mind. However, it has been shown that older users desire to use such products to remain active within society; often feeling that these technologies and products are not suited to their needs (Goddard and Nicolle, 2012).

A study devised to understand how middle-aged adults aged between 45 and 54 years old, learned to use computers was comprised of two phases, a basic computer training task and a usability study of the computer interface (Chou & Hsiao, 2007). There are a number of older adults' characteristics which are seen as crucial for their interaction with technology. The three main characteristics indicating a reduction in functions with age include 'sensory performance' (Kline & Scialfa, 1997), 'motor performance' (Vercruyssen, 1997a) and 'cognitive performance' (Craik & Salthouse, 1992).

Amongst the cognitive factors that decline with age are memory functions and spatial abilities. Such abilities are crucial for accurate navigation behaviour; where older adults are at a disadvantage when faced with tasks that require navigation (Ziefle & Bay, 2007). As people age, motor behaviours change, they take longer to make movements similar to that of younger people (Vercruyssen, 1997b). Furthermore, older people tend to have reduced working memory capacity (Zacks, Hasher & Li, 2000); all of these characteristics connected with older age may influence their use of computer input devices.

Cognitive changes through older adulthood affect the way in which users interact with technology and the way in which they perceive touchscreen products. Cognitive complexity refers to basic procedural knowledge of how and when to perform a task on a computing device which is then stored in one's long term memory (Ziefle & Bay, 2007). In their study of usability of two mobile phones, namely A and B with differing cognitive complexity they found that there were clear differences between the phones of different complexities. The group of participants were divided into two user groups in the range 20-35 and 50-64 years old. Differences were observed between these groups and how they interacted with the mobile phones, where they found that the older users had poor navigation of the interface in comparison to the younger group. In order to obtain information of how older users interact with such devices, a theory was devised whereby the user's aspirations were tested against the actual output of the computer. The 'Cognitive Complexity Theory' (CTT) was proposed to evaluate how the users goals on one side and the reaction of the computer on the other (Kieras & Polsons, 1985).

Peischl, Ziefle, & Holzinger (2012) declared that end-user friendly interface design was of tremendous importance for the success of mobile applications which in the e-Business. They presented an empirical evaluation of a mobile information system for improving navigation of public transport. The central hypothesis of their study was that useful, useable and accessible navigation contributed towards making public transport systems more attractive.

Peischl, Ferk, & Holzinger (2013) reported on collaborative work in developing a system for data acquisition in healthcare organisations, providing mobile data support. They briefly introduced the ICF and the ICD classification scheme from the WHO as a foundation for our mobile application. From their work they deduced recommendations (and open issues) concerning the user interface design of the mobile application.

In contrast, a study conducted by Kang and Yoon (2007) compared the differences between how younger adults and middle-aged adults interacted and completed a series of tasks using two different devices. An MP3 player and a PMP (multimedia player) containing an MP3 player, FM radio, JPEG photo capability were the products used. The participants were adults from two age groups: 20 to 29 years old and 46 to 59 years old. Both age groups were required to perform basic tasks on both products and the interaction with either product was monitored. As predicted, the older adults were found to be slower at performing tasks and encountered more errors than the younger age group.

The link between user and input device is critical, as human interaction with computers is a three-part union, engaging a human, a machine, and an interface. Comparative study of a touchscreen product (direct input) against a button faced product (indirect input) highlighted differences between users of different ages (Rogers, Hertzog, & Fisk 2000). The groups chosen were 18 to 28, and 51 to 65 year olds, both with 40 participants per group. The age range for the older age group was deliberately chosen to be representative of the 'older worker.' The participants performed identical tasks on both products, with each task having five to seven steps before completion, alongside this, with each task a step-by-step guide was shown via a PowerPoint presentation for all participants. The touchscreen device used required bare finger interaction, and was fully attached to the desk so users could only interact with the actual screen. The second device used was a rotary encoder consisting of a rotary switch and a push button, but this product was hand held, allowing for users to hold it freely.

Younger participants had a much faster response when using the touchscreen, with the older users being faster when using the indirect input device. The comparison revealed that the younger participants favoured the direct input device (touchscreen), and the older users preferred the indirect input (the rotary encoder). The study showed that older people's movements were more variable in their ability to use a touchscreen to make discreet movements. A factor which may have influenced how the older participants interacted with the touchscreen device could have been impacted as the product was fully attached to the desk. Therefore, not allowing for a natural interaction with the product, likely movements may have encouraged the user to hold the device in way in which they felt comfortable and could have improved their usability (Rogers, Fisk, McLaughlin & Pak, 2005).

With services becoming more technology based, and many services now converting to the internet as a primary access point for contact, the aging population feel the demands of keeping up to date with the ever changing technologies. As the segment of older people increases, the need to conform and use new technologies is evident. Although mobile phones were created to maintain communication whilst on the move, the changes in technology have now shown that smart phones are most commonly used to browse the internet as well as social networking, these being the top two functions. Making phone calls falls 5th in the top 10 of activities carried out on a mobile phone, after browsing the internet, social networking, playing games and listening to music. With smart phones being designed with social networking and internet browsing as central features, the more basic functions are in the background; this may also influence the amount of use by older adults.

Frustrations with using touchscreen technologies are not only reported by older users, younger groups also find difficulties but are generally better at adapting to technological changes. Although this is generally the case, improving the design to enhance usability for older adults will therefore improve usability for other user groups as well (Czaja et al, 2006). Despite advances in technology design and efforts undertaken to make technologies and interfaces user friendly and useful, older adults still remain slower at adapting to technologies and are more likely to feel anxiety when attempting use of a new system (Czaja, et al, 2006). Other research states that the size reduction of many devices has complicated ease of use for older users, therefore more time is taken to carry out tasks on new technology based products (Kang & Yoon, 2007).

Studies have shown that, given the choice, older people often decide to involve other people in different stages of interaction when using new technology (Kurniawan, 2008). However, this attitude is often used as a confidence building mechanism for users that experience some degree of computer or technology anxiety, but are keen to learn for themselves. Burrows' study also found that older users are keen to make their own decisions and do things for themselves, but there are often tasks which they enlist the help of others regardless of their ability. It was also found that during the early stages of interaction with an unfamiliar device, older users found this an opportunity to spend time with other people; therefore, showing how some products may provide social benefits (Kurniawan, 2008).

Further studies have shown that as expected, complicated multi-functional devices tend to be more challenging for older users in comparison to their younger counterparts (Curzon et al, 2005). Visual information detail and 'useless' information can be off putting for older adults when interacting with such products. 'Useless' information such as advertisements, decorated text and animation undesirably impact upon task completion more regularly with older adults than younger adults. Therefore, older adults are more likely to have difficulties in recognising and selecting wanted functions amongst other various information displayed on screens of multi-functional devices (Chang, 2013).

Holzinger, Geier, & Germanakos (2012) provided a context aware solution for mobile end users that provided different levels of interaction. They hypothesised that simple user interfaces enhance performance and reported on some lessons learned during the design, development and evaluation of a smart, adaptive user interface for an e-Business application. Furthermore, Holzinger, Lehner, Fassold, & Holzinger (2011) presented the design and development of a mobile application to support archaeological education and to raise awareness for our cultural heritage by making use of the powerful notion of play. The application read information from Quick-Response Codes (QR-Codes) on paper sheets, be placed directly at the points of interest.

Previous studies conducted generally consist of older users in comparison to their younger counterparts. These studies also tended to use older adults aged 50-65, making them still part of the active workforce, whereby they are more likely to be familiar with new technologies. It was also found that the cognitive changes through later adulthood impact the way in which older people interact with such products (Kieras & Polsons, 1985). Research has shown that although older users do not shy away from new technologies, they do often become frustrated within themselves when learning how to use a new product or technology, (Czaja et al, 2006) due to them being educated during a time where advanced technologies were not prominent in everyday tasks, unlike in today's society. Despite many studies focusing on older users and technology, there seems to be a gap in the literature on the use of touchscreen mobiles

phones in comparison to key based mobile phones by older users. This forms an appropriate basis for a study of this context to be designed.

Different mobile platforms provide challenges for usability as reported by Holzinger, Treitler, & Slany (2012) who reported on experiences during an industrial project on building user interfaces for database access to a business enterprise information system for professionals in the field. They discuss their systematic analysis of standards and conventions for design of user interfaces for various mobile platforms, as well as scaling methods operational on different physical screen sizes. The interoperability of different systems, including HTML5, Java and .NET was also within the focus of this work.

RESEARCH METHODS:

Qualitative research methods were chosen in order to obtain insights into how this group of users interacted with touchscreen interfaces. The chosen method of observation was structured observations, involved watching the participants in the given situation and recording the on-going activities. This was chosen as a more realistic outcome could be obtained during the task study. From structured observations, each participant was given the same tasks to do, ensuring no participants were at a disadvantage of task difficulty and providing consistency of the research conducted with each participant.

The research design study was designed to obtain insights in to how older users feel when using and interacting with touchscreen products in comparison to a button faced product. All participants were asked to undertake a short semi structured interview prior to the task study. During the interview, questions were asked about their current perceptions regarding the usability of touchscreen products. This was done to uncover any preconceived ideas that the older users may have had about touchscreen products in contrast to button faced products and to provide the basis for comparison between user perceptions and experience. The study required the participants to carry out a series of simple tasks on a touchscreen phone, and then to repeat these same tasks on a button faced phone. The participants were timed to compare their performance for both products. As well as being timed, each error and any help given was also recorded. This is important to the study as it exposed any reoccurring trends between the participants when interacting with the products. The participants then took part in a short semi-structured interview upon completion of the tasks to see if their perceptions of touchscreen use had changed and to gain further insight into usability issues.

The study used participants of both genders that are 65+ years of age. This age was chosen as a benchmark as it is the standard age of retirement for UK citizens, although there is now not a compulsory age. This age group was also selected because they are less likely to encounter touchscreen technologies than those younger adults who may use such products within their workplace. This research study differs to that of Ziefle & Bay's whereby the research undertaken was to understand age effects in navigation performances of mobile phones differing in complexity (Ziefle & Bay, 2007). The study's variables were adults aged 20-35 years old and adults aged 50-65 years old. This study was devised to understand the cognitive complexity imposed by technical devices, in particular, that of the older adults which are still part of an active workforce. Therefore, adults who are retired are less likely to encounter such technologies in comparison to those of Ziefle & Bay's study. Ziefle, Himmel & Holzinger (2012) examined the effects of gender and age on technical interest in specific technology fields and found that general interest in specific technology is significantly influenced by gender and age.

The chosen products were a smartphone, Handset C, and Handset D. These two mobile phones were chosen as the desired tasks are compatible on both phones. An Apple iPad was considered for the study, however, this option was ruled out as the size difference and function would not be similar enough for direct comparison when carrying out tasks, making the results unrepresentative of the findings. The two phones were chosen so a sense of similarity will be found when the tasks were being carried out. The same four tasks were chosen for the participants to carry out on both phones. As both types of phone differ vastly in terms of features, the selected tasks were chosen carefully so the best results were gained from the study. Handset C is capable of many features that the other handset is not able to do, therefore, the selected tasks had to be correct. The chosen tasks:

- To call 'home' from the contact list
- To add a number and save as a contact in the contact list
  • *Add 07776135415 and save contact under the name 'John'*
- Write and send a text message
  •*Compose text message reading : 'Hi how are you?' and send to contact 'Mum'*
- Set an alarm clock for 17.30

Figure 1 & 2 - Phones used during tasks. Figure 1 – Handset C & Figure 2 – Handset D

The participants were timed and a maximum time limit of 3 minutes set for completion of each task. A time limit was set so time was not wasted on tasks which the participant may have found difficult, more importantly; the time limit set was to ease self-frustration for the participant. Frustration when completing one of the tasks may have impacted the way in which the participant approached the remaining tasks. An encouraging attitude was maintained if a participant failed to complete a task to avoid dis-empowering them. The chosen tasks are basic in procedure, and they are all functions which are often used when using a mobile phone. Some of the tasks set can be accessed various ways on Handset C, so the approach to the task was noted.

METHODOLOGY

Table 1 shows the study structure and the reasons for each part of the research study used.

Table 1 structure of study and research methods.

Research Task	Reason For Chosen Task
Pre study semi-structured interview	Designed to make the participant feel comfortable with the interviewer, and to build a flow of conversation. To find out what types of technologies the participant is familiar with. To understand their current perceptions of touchscreen technologies.
Task 1 – Call pre-saved contact named 'Home'	Designed with the contact already pre-saved to avoid confusion of the participant thinking they are being asked to call their 'own home' number.
Write and send a text message	To see how older users navigate through various menus to get to the desired action.
Add and save a given number as a contact	Intended to understand how the participant will navigate through two keyboards – alphabetical and the symbol keyboard used for punctuation.
Set an alarm clock for 17.30	Designed to understand how older users interact with typing on an onscreen keyboard in comparison to a traditional button keypad.
Post study semi-structured interview	Designed to see which information the participant thinks is relevant and needed from the listed options when adding a new contact to the contact list.

PILOT STUDY

Interview questions were set for piloting to test their appropriateness before the main task study could commence. The questions were piloted using an older adult, these initial questions for the pre and post task study. From trialling the interviews, the questions were considered to be repetitive and some were structurally weak. Alterations of the questions were done and piloted again before the full study took place with four participants. The broad expectation upon review of the obtainable literature, was that the participants would find the Handset D easier to use than the Handset C. It was predicted that the participants in this study had used a mobile phone, and were comfortable with use of this type of product; however, they were not expected to be experienced users of any form of touchscreen products.

With regards to usability of the mobile phones, it was also expected that participants would find problems in terms of navigation through menus when using the touchscreen phone. It was also anticipated that participants would ask for assistance and reassurance when working through the set tasks. It was predicted that the participants were going to complete the tasks within 3 minutes, or come very close to completion per task. Whilst undergoing each task it was expected that participants were going to comment on similarities and comparisons found between their own mobile phone and the task phone, in particular with the older users of the participant group. Overall, it was predicted that the participants would generally find usability harder with the Handset C, but they would find it enjoyable to use. The Handset D was predicted to be the favoured phone by the participant group.

Participants were chosen to represent three age groups covering 60, 70 and 80 years old to ensure a true reflection of the 'older adult' user group as a whole. Research was conducted with two sets of couples; the group consisted of two males and two females. The first group was a 66 year old female and 71 year old male, with the second group being a female aged 87, and an 88 year old male. From here on, participants will be referred to as P1, P2, P3 and P4. Table 2 shows which touchscreen products/services each participants has previously used.

RESULTS

The following results highlight insights gained from carrying out a pre- and post- task interview with each participant. Results of the task study also show the differences between users and how their previous experiences are reflected in the outcome of their task study results. Although this may be seen as an imbalanced variable, it was done so not one participant was at an advantage over the other. This allowed for a more precise account of interaction with each product to be taken, as well as a comparison between the users.

From conducting the pre-task study interview, it was highlighted that participants 1 and 2 were keen users of modern technology, with the second group being less technology orientated. These participants fell neatly into two clear groups, which allowed for comparisons to be made of the two extremes of technology use. P1 was a user of two phones, an Apple iPhone 4S, and a Motorola Gleam+, the latter being a key based phone. The participant used both phones on a daily basis, yet preferred the iPhone. Ease of use was asked to be ranked of both products, using a scale of 1-10, with 10 being extremely difficult, whereby P1 ranked the iPhone at a 3/10, and the Motorola at a 5/10.

Table 2: Participant's previous experiences

Product / Service	**Participant 1 Aged 66**	**Participant 2 Aged 71**	**Participant 3 Aged 87**	**Participant 4 Aged 88**
Mobile Phone (Touchscreen)	✓	✓		
Mobile Phone (Key Based)	✓		✓	✓
Tablet	✓	✓		
Banking Machine		✓		
MP3 Player	✓	✓		
Ticket Kiosk		✓		

When asked to list other touchscreen products/services she used, P1 also regularly used an Apple iPad. She was then asked to rate the ease of use of the touchscreen in these instances, where the iPhone's touchscreen was rated a 1, and the iPad rated 2. The participant was asked to list any problems that she found with the touchscreen, whereby none were found. The participant was asked to list any aspects they liked about the touchscreen of both products which can be seen in Table 3.

Table 3: P1 opinion of the touchscreen per product.

iPhone 4	iPad
Easier than buttons • Direct • Quick to use • Preferred to the Motorola Gleam+	Responsive • Mobility • Good for reading • Bright and very clear

Although P1 was a regular touchscreen phone user, she was still asked whether or not she would expect a touchscreen interface to be any different to a key based interface, to gain any insights into previous experience. The participant stated that having use a touchscreen phone, she would not revert back to a key based phone, as the ease of use was much better with a touchscreen interface. P1 also stated that she felt less of a fear of anything going wrong when using a touchscreen phone as it feels seamless to use.

P2 displayed similarities to P1 in terms of previous technology use. P2 was a user of an Apple iPhone 3GS, using it on a daily basis. He rated his phone a 3/10 for ease of use, leading on to say that there were *'too many apps'* on his phone which he never used such as the camera, alongside this P2 was a regular user of self-banking services. The Apple iPad was rated a 3/10 for the ease of the touchscreen, and the banking service rated a 2/10. Initial problems were found with navigation and menu selection with the banking services, stating that he would never have used this service regularly had he not been encouraged by staff. However, P2 did say that he would have experimented with the service once to see how it worked. Aspects of what P2 liked about the touchscreen in each instance is shown in Table 4.

Table 4: P2 opinion of the touchscreen per product

iPhone 3GS	**iPad**	**Banking Service**
• Simple • Easy to fix mistakes • Easy menu	• Easy menu to use • Instant	• Quick response • Easy to fix mistakes • Simple • Straight forward

P2 found that his phone often came on in his pocket, and without realising a call would be made, due to slight interaction with the screen. When asked if he thought there would be any difference between a touchscreen interface and a key based interface, he stated that he felt that touch is far easier as it gave him *'instant feedback'*. Unlike P1 and P2, participant 3, aged 87 had never used any touchscreen products/services, however did have a mobile phone. P3 used a Sagem MY150X, only using it around once a month. On a scale of 1-10, P3 rated the phone 3/10 in terms of ease of use. She had never used a touchscreen product/service and was uncertain of what the term 'touchscreen' actually meant even after examples were given. Although she had never experienced any touchscreen products, she did state that she would expect a touchscreen based product would be fairly easy to use. She assumed that touchscreen products will be easy to use and will be *'quicker'* than a button faced product.

Similarly to P3, P4 also had limited interaction with modern technology. P4, aged 88 also used the same mobile phone as P3, using around twice a month. He rated his mobile phone a 2/10 for ease of use, he stated that the only problem he found was that the *'numbers sometimes don't do what they're meant to.'* He also said that he and P3 often get *'told off'* by their children for not taking their mobile phone with them when out. He then went on to explain that the phone is mainly used for others to contact him, and was rarely used for outgoing calls. When asked if he felt that a touchscreen interface would be different to that

of a key based phone, he stated that he would prefer a touchscreen because it looks like it would be quicker, and any mistakes can be corrected easily. P4 was then asked how easy he was expecting the use of a touchscreen phone to be, he stated that he believes he could easily get used it to over time, '*the proof of the pudding is in the eating.*'

From the pre-task interview, it was shown that all participants were expecting the touchscreen phone to be fairly easy to use. Each participant stated that they assumed the touchscreen phone will be 'quicker' and 'easier' to use. Although only P1 and P2 had previously used touchscreen products, P3 and P4 believed that a touchscreen interface would not be hard to use, but in fact, easier and clearer to use. These assumptions were based purely on the impressions that the name of the technology gives as neither participant had previously encountered such interface. The next stage was for the participants to undertake the task study. The participants began the task study using Handset C, attempting each task set before repeating on the Handset D. Tables 5 and 6 show the problems encountered during each task, and time taken with Handset C.

Table 5: Problems encountered with the touchscreen phone during each task for P1 and P2.

Task Number	**Participant 1**	**Participant 2**
1	• No help needed. • 36 secs taken.	• Rang two different people before calling the right number. • 57 secs taken.
2	• Needed help how to find main menu icon. • Help given on where to begin to add contact number. • 2 mins 42 secs taken.	• Needed assistance on how to begin procedure of adding in new contact. • 'Smart dial tips' was chosen opposed to adding contact through 'people' app. (Refer to figure 6 and 8). • 1 min 12 secs taken.
3	• Did not know where to begin for text message app. • Help given how to use keypad to text. • Help given when trying to add recipient. • Had never sent a text message before. • Help given how to add recipient. • 2 min 45 secs taken.	• Wrong letters were chosen. • Used text abbreviation. • Successfully added contact. • 2 min 48 secs taken.
4	• Help was given to access to clock app. • Did not realise that time must be in the middle of the scroll section for desired time (refer to figure 15). • Was tapping the number to try to select instead of scrolling. • Help given on how to 'save' the alarm time. • 1 min 15 secs taken.	• Prompt was given how to access clock features. • Did not know how to 'save' the alarm time. • 1 min 45 secs taken.

From the post task interviews is was highlighted that P1 and P2 both preferred the touchscreen phone. Unexpectedly, P3 also preferred the touchscreen phone in comparison the button faced phone. A reoccurring trend that was found was the clarity of the screen and the direct relation between the icon on the screen and the application it represented. P4 was the only participant to prefer the button based phone over the touchscreen phone. P4 found the button faced phone to be easier to use as having found a similarity to his existing phone. Having said this, P4 did state that he did find the HTC easier to use than he had first anticipated, as he found that it 'flowed easily' and was 'smooth' in terms of operation. P3 also found that the HTC was easier to use than she had expected, as it was 'easier to see what was happening.' P1 and P2 both found the Samsung much harder to use, stating they were certain it was going to be very simple to use. P2 expressed he felt there were too many steps to be taken before reaching the desired action when using the button faced phone. P1 found the keys to be too small, and the arrangement of the letters on each key to be over complicated as the phone was of a lower specification.

Table 6: Problems encountered with the touchscreen phone during each task for P3 and P4.

Task Number	**Participant 3**	**Participant 4**
1	• Did not know where to begin – had to be prompted. • Afraid to select desired icon & asked for reassurance before pressing. • Did not understand the scroll feature for selection. • Could not find a balance of how hard/light to press the screen. • 1 min 47 secs taken.	• Was unsure of how hard to press the screen. • Option which he wanted to select and what was actually chosen were different. • 1 min 40 secs taken.
2	• 'I've got to put that on there?' referring to adding a number into the contact list. • Prompted show how the keypad worked. • Often touched the screen accidentally, leading to an undesired action. • 2 min 33 secs taken.	• Pressing numbers, but was not looking at what was appearing on the screen – wrong numbers were pressed. • Found QWERTY keyboard confusing. • Found this task 'confusing.' • Reached time limit
3	• Did not realise that the icon needed to be touched to enter the app. • Wanted investigator to press the icon for her, even after being prompted. • Found QWERTY keypad quite difficult due to letter arrangement and pressing unwanted letters. • Prompted to add punctuation by holding down 'hot key' (refer to figure 10).	• Poor navigation through keyboard – often forgetting where 'space bar' was. • Did not understand the difference between pressing a key, and holding the key when trying to add punctuation, more pressure was needed. • Chose to use 'hot key.' • Managed to write full text

	• Managed to write full text message, did not add recipient and send. • Reached time limit.	message but did not add recipient and send. • Reached time limit.
4	• Doubt before attempting task. • Needed to be shows scroll feature. • Panicked after scrolling too far. • Did not realise time needed to be in the middle of the bar. • Reached time limit.	• Was unsure of which row the numbers needed to be in to set the alarm. • 1 min 35 secs taken.

Tables 7 and 8 highlight the problems experienced with the Handset D, and the time taken for the completion of each task.

Table 7: Problems encountered with the key based phone during each task for P1 and P2.

Task Number	**Participant 1**	**Participant 2**
1	• Buttons above the call/end call were missed – used for selection and cancel. • 32 secs taken.	• Did not know how to navigate through menu • Icons and titles were too small • 57 secs taken.
2	• Automatic keypad lock – confused how to unlock even after being shown. • Added contact through phonebook from menu. • Managed to add number, but did not finish typing the name, so contact was not saved. • Reached time limit.	• Began to add in phone number, but called instead of saving contact. • Called existing contact twice. • Got frustrated with himself. • Added number, but did not manage to add name. • Reached time limit.
3	• Could not navigate from the recipient box to the text box – prompt was given • Tried to add text, but confused with letter selection was found difficult. • Cancelled text message and gave up completion of task at 2 min 30 secs. • Gave up at 2 min 30 secs.	• Entered and exited the main menu 4 times. • How to compose the message had to be explained to participant. • Stated that having to use this phone would ‘drive him crazy.’ • Could not see the keys above the call/end call buttons. • Gave up at 2 min 30 secs.
	• Did not know where to start for time functions. • Side arrows were needed	• Entered and exited menu twice. • Did not know that the

4	for setting the on/off option for the alarm, she did not realise until prompted. • 2 min 01 secs taken.	side arrows were needed for activation of alarm. • Found the silver navigation key 'fiddly.' • 1 min 55 secs taken.

Surprisingly, P3 and P4 said they would be prepared to use a touchscreen product again, as they believed it was a technology they could get used to with practise. P3 and P4 did not find any task harder than the other, and felt as though all tasks were equally as hard; however, using text features on the key based phone was extremely difficult. P1 found mastering the letter selection on the Samsung a lot harder than she had expected. She felt the keys were too small, and the speed of which the keys needed to be pressed was too fast. As predicted, P1 and P2 stated they would choose a touchscreen phone, if they were to have a new mobile phone. It was believed that the screen was a lot more accessible, and the apps were obviously placed through the menu, making it simple to get to desired applications. Both P1 and P2 found the HTC harder to use than their own iPhones, yet not as hard to use as the Handset D.

Table 8: Problems encountered with the key based phone during each task for P3 and P4.

Task Number	**Participant 3**	**Participant 4**
1	• Due to automatic keypad lock, she was confused as when to hold the unlock key, and when not to. • Found silver navigation key very confusing. • 1 min 50 secs taken.	• Began task by touching the screen, as the previous phone used was touchscreen based. • The participant found the 'call' button hard to understand, and prompt was given. • 1 min 45 secs taken.
2	• Did not know where to begin with adding in new contact. • Prompt given to phone book. • Managed to add number but could not add name for contact to be saved. • Confusion with letter selection as various letters placed on each key. • Reached time limit.	• Began dialling in phone number, which was remembered from using Handset C. • Silver navigation key found hard, and help was given. • Did not know how to 'clear' when wrong character was selected. • Confusion with letter selection as multiple letters per key. • Managed to add number, and added 3 letters of the contacts name. • Reached time limit.
	• When on the right icon in the menu, participant did not realise that they needed to 'select' to complete the action. • Had to try the letter arrangement many times before understanding letter sequence. • Reached time limit.	• Had to explain how grid menu worked, with headings already given on screen. • Icon for each app was not clear; the icons were not taken notice of.

3		• Letter selection was still found to be hard, having used trialled this feature previously. • Keys were too small. • Managed to write 'Hi, how are' the message was not finished or sent. • Reached time limit.
4	• Navigation key difficult to use, as side arrows were needed to select on/off options. • She was initially using up and down, as that action was required when using the touchscreen phone. • 1 min 41 secs taken.	• Could not use navigation key easily. • When a selection was made, he expressed he found it unclear when action was completed. • Reassurance needed. • 1 min 47 secs taken.

Although P3 preferred the HTC and found it easier to use, the participant stated she would have a button faced phone if she was to have a new mobile phone. Furthermore, P3 said that she found the touchscreen easier to use than her own button faced phone, but would still have a key based phone if she was to have a new phone, as she felt more familiar with this interface. P4 also stated that given the option, he would also have a button based phone as it was 'clearer' and more 'straight forward.' Overall, the outcomes of the post – task study supported the hypothesis of this investigation. P1 and P2 met the expectations of the researcher, remaining supportive of touchscreen technologies and did not express any interest to change to a key based technology. P3 expressed interest in touchscreen technology and found it enjoyable to use, yet would choose button faced products over any interest given. P4 also remained supportive of key based technology, and did not express any interest in converting to a touchscreen mobile phone.

From the results and insights gained, table 5, it was shown that there many problems encountered with both phones by both the experienced touchscreen phone users, and the non-experienced users. Insights were gained by encouraging users to undertake a 'Think-Aloud Protocol' (Martin & Hanington, 2012). This strategy was chosen as it required the participants to vocalise their thoughts and actions revealing true feelings whilst undergoing the task study. Each participant's individual investigation was voice recorded so it could be referred back to. This was particularly insightful as many perceptions of technology were found when referring back to the recordings, as many of these insights were spoken during conversation opposed to during the interviews (refer to Table 9).

Table 9: Insights gained from participants during individual investigations

Phone	**Insights**
Handset C	• "I thought I would be so much quicker because it's like my phone." *(P1, Task 2)* • "This phone is like mine but I'm not as good at using it." *(P2)* • What am I doing? That's not right." *(P3, Task 4)* • "I'm going to be here all day." *(P3)* • "I would say that in the long run, a child could learn it quicker than we can at our age." *(P4)*
Handset D	• "I've failed at finishing it." *(P1, Task 3)* • "This phone is so hard, it would drive me crazy." *(P2,*

	Task 3) • "I thought I was intelligent." *(P3, Task 3)* • "This is like most things, the more you do it, the easier it becomes" *(P4)* • "I would never have thought the silver bit was part of the system, it just looks like an ornament." *(P4, Task 2)*

The results were found to be different for each participant in relation to each of the two phones. A recurring theme identified by all participants when using the touchscreen phone was that navigating through the menus caused confusion. Navigating through the menu on the key based phone also presented the same issues. The difficulties found by P1 and P2 were unexpected as they were identified as current touchscreen phone users. As expected, P3 and P4 had problems with the physical action required to complete actions with the touchscreen phone. An additional finding was that the participants found the interaction with the key based phone difficult at points throughout the tasks too.

Prior to the tasks being completed by P3 and P4, apprehension about their capabilities in interacting with these technologies was expressed. Requests were made by these participants for assistance in the task completion as they were unsure how to achieve what had been asked of them. The reasoning behind this user behaviour was found to be that the participants considered themselves 'too old' to be using technologies that were this advanced. Furthermore, during the task studies P4 suggested ways in which to tackle certain selections as P3 became more and more frustrated within herself. Suggestions such as *'you need to drag it,'* and *'you need to scroll.'* were mentioned to aid the other participant. Interestingly, when P4 came was completing the tasks himself through the study he did not carry out any of the suggestions previously made, yet asked for help.

In contrast to the expectations of the researcher, one of the non-touchscreen using participants was found to interact more easily with the touchscreen phone than the key based alternative. In addition to this, the final participant expressed his satisfaction with the touchscreen phone's functioning, as he had expected to experience more difficulties when interacting with it. It is felt that the reasoning behind this is the graphical design and icon layout shown on the screen. This would indicate that the user-product interaction has been well considered by the technology developers to ensure user satisfaction for all user groups. However, despite these obvious advantages to the touchscreen phone, the participants' responses from the post-task interview suggest that they still do not provide a high enough interaction experience to encourage their use by all older users. A thematic approach was used to analyse the results. This method was chosen based on the literature written by Martin and Hanington (2012) mentioned previously in this report as it was identified to be a successful technique in extracting the most common themes in rich qualitative data.

DISCUSSION

The research investigation that has been completed supports the literature that had been reviewed in many ways, as well as producing additional insights that had not been mentioned by other researchers. Goddard and Nicolle (2012) stated that older users would like to use touchscreen technologies to enable them to remain engaged in society, yet it was argued by Czaja et al (2006) that older adults were generally less likely to use these types of

technologies than younger generations. This study has developed an understanding which could explain the reasoning behind this. It was discovered that whilst the older adults would like to use newer technologies, they tend to continue using technologies they have previously experienced, due to their uncertainty in using newly developed technologies.

The participants in this study also supported the views of Goddard and Nicolle (2012) that highlighted the fact that whilst older users express an interest in using newer technologies such as touchscreen phones, they do not feel that they are designed appropriately for their age group. Insights highlighted within this study suggest the reasoning behind this could be due to the reduced memory capacity of older users – also discussed by Zacks et al (2000) – or the physical design of the buttons on the phone. The physical size of the product has an additional impact on the user experience for older users too, as discussed by Kang and Yoon (2007) – they increase the time it takes for a user to complete any single task, and reduce the efficiency of the user-product interaction.

A further reason behind older users not being as efficient users of touchscreen technologies as younger users was mentioned by Ziefle and Bay (2007) who described how they were at a disadvantage when trying to complete navigation tasks. During the study task, participants were seen to struggle with the concept of 'scrolling' on a touchscreen phone, which reduced their efficiency of their task completion – something which does not happen with younger users. The physical co-ordination and slower movement characteristics held by older users supported the views of Vercruyssen (1997), particularly being more prominent in the older users of the participant group.

The uncertainty seen throughout the study task completion with each participant often led to the expression of frustration and anxiety. Czaja et.al (2006) highlighted this within the literature reviewed previously in this report and this effect of technology use is something that needs to be addressed by technology developers to ensure their products are appropriate for the full range of potential users. User perceptions were one aspect that revealed a range of insights in relation to older users and touchscreen technologies. Whilst the literature suggested that all of this user group were reluctant to interact with these technologies, the participants of this study did suggest otherwise on occasion, as one participant expected the touchscreen phone to be easy to use. With only a small sample of participants being used and this still being evident within the research, it is clear that more research needs to be conducted in the area of older adult user perceptions to ensure that their desires are being met as well as their physical and cognitive needs.

CONCLUSIONS

The study suggested that older users show a keen interest in learning and using advancing technologies, however; they often do not feel fully equipped to do so. From the research conducted it has been seen that some older users are frequent users of modern technologies such as touchscreens and find this easier to use than systems which are generally perceived as more 'simple' systems such as key pads on a mobile phone. Technology advances show a change in interface design, making use easier for all users, in particular older people, yet this has not been developed to its full potential and still deters certain users from choosing to use products implementing these technologies.

This study supports almost all of the views expressed within the reviewed literature and shows that touchscreen technologies are not as intuitive for older users as they are for younger generations. With many reasons being highlighted as explanations for this, it could be assumed that this situation will continue until the younger generations reach this age.

However, there are changes that can be made by the technology developers to enable older users to access more recent technologies such as touchscreen phones. The simplest way to ensure this happens would be to integrate these technologies at a simpler level into products which older users may encounter. Once this user group felt comfortable using the basics of this technology and had confidence in their ability, they could then progress onto using other products which integrate more touchscreen features, without causing them to be put off by a 'big leap' between user-product interaction styles. Upon reflection of the research outcomes it is recommended that technology developers consider the needs and desires of older adults as a user group. Combining this with a more appropriate level of technology advancement, developed with this user group in mind would result in new technologies being more accessible and usable for older adults. Limitations within this study were due to participant recruitment.

The research completed in this investigation could be advanced by repeating the same tasks with a larger population. Due to time limitations and participant recruitment constraints research into differences between genders could not be done. By having more participants, any differences caused by gender could be highlighted and may produce additional insights which would have the potential to guide technology developers' success at providing for more user markets. This would also form more definite results as quantitative analysis could be conducted. In addition to gender comparison, comparing sub groups of age would be a further opportunity to establish any other differences between more narrowly defined user groups.

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