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Attitudes towards Attention and Ageing: What Differences between Younger and Older Adults Tell Us about Mobile Technology Design

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ABSTRACT

Errors in interaction with digital devices are typically blamed on human factors such as poor attention. However, the influence of attention upon the quality of human-device interaction is commonly overlooked in product design. Developers rely on feedback through user centred design, but do developers, typically younger adults, understand what an older user means, or experiences, in terms of “attention” and appreciate that fundamental conceptual and experiential differences may exist? The authors examine differences between older and younger adults’ concepts of attention in relation to mobile-device use to inform future development. Two participant groups consisted of 11 younger adults (18-30 years) and 12 older adults (65+ years). Qualitative analyses revealed three themes ‘personal understanding of attention’, ‘attention is dependent on...’, and ‘impact of ageing’.

KEYWORDS

Ageing, Attention, Cognition, Focus Groups, Mobile Design, Older Users, Qualitative Study, Younger Users

INTRODUCTION

The design of mobile technologies and their interfaces has evolved dramatically over the past decade in the hope of making them easier to use. They pervade many aspects of everyday life but, among older adults, the technology is frequently still seen as fiddly, awkward to use, frustrating, distracting or somehow inappropriate. Even amongst older adults who were introduced to the technology while still working, the constraints of a mobile interface can make using their devices seem cumbersome. Errors in interaction with digital devices are typically blamed on human factors such as poor attention and forgetfulness (Thimbleby, 2007). Mobile devices’ smaller interfaces present obvious challenges to older users whose senses and co-ordination typically decline with age (Li & Lindenberger, 2002; Lin et al., 2014). This decline is widely known of, although not routinely addressed by designers (Gregor, Newell, & Zaccijek, 2002). We argue that a critical element of mobile design is often overlooked when trying to understand the disconnectedness observed between older adults and their devices: attention-related differences between typically younger users and designers and older users. This oversight is

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interesting as mobile designers know their technologies are used on-the-go in environments where there are many distractions and they take account of this influence of the environment on interaction with their devices (Lee & Benbassat, 2003). Even worse, the device itself can be intrinsically distracting. If the mobile device is difficult to use, awkward or frustrating, then attention will be focused on this rather than on the actual task. Only information at the focus of attention tends to be processed to the high levels required for optimum cognition, perception and action. Irrelevant attentional capture, can therefore lead to a reduction in the efficiency of information processing, memory, cognition, perception and behaviour. Such factors may affect the use of mobile devices by older adults to a greater extent than for younger adults as multidisciplinary research indicates that some aspects of attention-related function and immunity to distraction decline in efficiency with increasing age: factors rarely considered in relation to product development. However, the potential importance of such factors is highlighted by emerging evidence that indicates that decline in cognitive functioning affects the speed and accuracy of using complex technological products in older adults (Blackler, Mahar, & Popovic, 2010; Lewis, Langdon, & Clarkson, 2007; Lewis, Langdon, & Clarkson, 2008; Groth & Allen, 2000).

Understanding these issues is challenging as, from a cultural perspective, younger and older adults may interpret their own capacity for attention in different ways. This poses a serious challenge for the designers of mobile technology who almost exclusively belong to younger demographics (Gregor, Newell, & Zajicek, 2002; Newell & Gregor, 2000; Pullin & Newell, 2007). Moreover, it has a significant impact on interpreting the outcome of a product test through user experience design; the older user and the younger designer may not be in line in terms of communication. Although attention is a word or concept in common use, we know little of what the general public understand by it. A lack of correspondence between what the public and device-designers understand by attention, how it might relate to the use of a device, the production of errors and what factors can affect it, is therefore likely to result in a sub-optimum product design. For example, if a designer wanted to discuss attention would both he/she and the older person understand that term in the same way and have the same descriptors and interpretation of its effects? Does the developer see the attentional related aspects of the interface as potentially different in older and younger adult users? Are errors the same in young and older adults?

In the Mobile HCI, Pervasive Health and Ubiquitous Computing arena there is an abundance of literature about reminiscence therapy (Gowans et al., 2004; Lee et al., 2014), memory games (Cherniack, 2011; Tost et al, 2014) and reminders (McLarty et al., 2008; Donnelly et al., 2010; Lin et al., 2014) where the focus is on memory. However, before memory capacity even becomes involved, inefficient attention may render information less likely to enter memory (Turk-Brown, Golomb, & Chun, 2013). This indicates that it is not simply memory that can affect performance but related aspects of information processing, such as attention. Moreover, it is worth noting that although there are a number of long and short term studies on the topic of attention and complex user interfaces (Blackler, Mahar, & Popovic, 2010; Hawthorn, 2007; Reddy, Blackler, Mahar, & Popovic, 2010), researchers and designers in the area of mobile HCI have overlooked the potential impact upon design of age-related differences in the concept and descriptors of attention.

In this article we will attempt to help designers address this by investigating what both younger and older adults intuitively understand by attention through the lens of interactions with a typical mobile tablet device. Therefore, this interdisciplinary research makes a contribution to understanding the effect and implications of the ageing process for mobile design.

Related Work

In the psychological domain, attention is understood as a process that enables us to adequately function in a highly perceptual stimulus-driven world. Ideally, we are able to selectively attend to what we want and need to, and inhibit our attention from irrelevant/distracting stimuli. Attention can be consciously paid to something but can also be involuntarily diverted, for instance to a sudden loud noise. Robertson, Ward, Ridgeway, and Nimmo-Smith (1996) propose three distinct types of attention:

1. 'Selective attention' which is the ability to filter out stimuli whilst focusing on another stimulus.
2. 'Divided attention' is the sharing of attention between different stimuli.
3. 'Sustained attention' is the focus of attention to particular stimuli over time.

However, while this is the concept that designers and psychologists have of attention, is this what the general public immediately and intuitively understands by it and would the general public categorise, describe and discuss attention with the developer in these terms?

Further exacerbating this potential dichotomy between the public and designers is the possibility that the understanding of attention amongst younger and older adults and designers does not necessarily match with the behavioural requirements and experiences of the individual using the device. This creates a pitfall for designers who come to understand that ageing can be associated with a reduction in attention but fail to fully understand what is meant by the term. This lack of common understanding and/or clarity of terminology may lead to suboptimal communication between the developer and the user. In this article we will attempt to help designers address this by relating our findings to essential principles of design and the practical/behavioural use of the devices.

Attention in Interaction Design

Human computer interaction (HCI) literature often links the subjects of attention and errors. If the use of a device is associated with a high degree of error then the individual will not use it. In HCI, Don Norman has been one of first few researchers who explored the link between attention and action (Norman & Shallice, 2000). His early studies show that people typically rate themselves as "distracted" in the situations wherein lapses occur; arguably therefore, inappropriate attentional demands can result in errors.

Don Norman (Norman, 1988) in "the design of everyday things" argues that making errors is part of our human nature. He provides a comprehensive description of "lapses" in interaction with everyday devices and how they can be avoided. As errors are inevitable, the devices should allow their users to (1) understand the cause(s) of error, (2) make it possible to undo actions and, (3) make it easy to fix errors (Norman, 1988; Thimbleby, 2007). In interaction with digital devices the context of use can sometimes determine what is the best interface to use to reduce "lapses" and being easy to use cannot be generalised to all contexts of use for one particular device (Eslambolchilar, Webster, & Niezen, 2013).

There are a limited number of studies in HCI that assess the impact of mobile notifications on the users. For example, Pielot et al. (Pielot et al. 2014) report on a one-week, in-situ study involving mobile phones users aged 24- 43 ($M_{dn} = 28$, $M = 30.46$, $SD = 6.04$), where they collected real-world notifications through a smartphone logging application alongside subjective perceptions of those notifications through an online diary. They found that an increasing number of notifications was associated with an increase in negative emotions, however, receiving more messages and social network updates also made our participants feel more connected with others. Pielot et al.'s findings are consistent with Sahami et al. (Sahami et al. 2014) who collected more than 200 million mobile notifications from more than 40,000 smartphone users. Sahami et al. also found that important notifications do not necessarily cause immediate attention: their results support the assumption

that important notification cause immediate attention. The correlation is, however, weak. It can be concluded that there is a difference between being important and requiring immediate attention.

The role of attention and ageing has been studied in the context of day-to-day interaction with digital devices such as microwave ovens (Lewis, Langdon, & Clarkson, 2007) and digital health equipment at a gym (Reddy, Blackler, Mahar, & Popovic, 2010) however, this topic has been largely overlooked in interaction with mobile devices.

STUDY DESIGN

In this study we investigated the distinctions between older and younger adult members of the general public in their attitudes towards attention and factors that influence it. By doing this we hoped to allow those who design technology that might be used by older adults to understand what their own assumptions about technology are and where those assumptions can lead them astray in designing digital systems.

To examine this we employed a cross-sectional study with a qualitative approach to data collection and analysis. Individuals drawn from the general public were invited to participate in a focus group.

Study Population

Two participant groups consisted of 11 younger adults (18-30 years) and 12 older adults (65+ years). The 11 younger adults participated in one of two separate younger-adult focus groups, and the 12 older adults in one of three older-adult focus groups. The younger adults were recruited via University block emails and electronic notices. The older adults were recruited via the Older People and Ageing Research and Development Network (OPAN) and the local 50+ Networks.

Potential participants were provided with study information and contact details for the research team. Interested individuals were assessed on the study inclusion and exclusion criteria. The inclusion criteria were that they fitted one of the two age groups and that they were in good general health. Exclusion criterion included recent participation in an attention-related study and knowledge of the psychological aspects and meaning of attention (e.g. those studying for a degree in Psychology). Suitable willing participants were subsequently booked onto one of the scheduled focus groups.

Focus Group

The focus groups were held in a meeting room within the Department of Computer Science, at Swansea University. The focus groups lasted approximately 1.5 hours. At the beginning of the focus group the participants were provided with the study information again and further briefed of the study process. Signed informed consent was then requested. The focus groups were audio-recorded and a member of the research team took notes. A semi-structured predetermined framework of open-ended questions was used to ensure all aspects relating to the topic area were explored. Three topic areas were covered (Table 1).

Data Analysis

The focus group recordings were transcribed verbatim, and all identifiable information was either removed or consistently anonymised. Thematic analysis was employed on the interview data, which was realist driven, inductive, and bottom-up (Braun & Clarke, 2006). Two members of the research team read and re-read the transcripts making initial comments and codes. The process was repeated twice more until individual codes were identified. Subsequently these were grouped into themes in order to highlight commonalities.

Table 1. Focus group topic guide

Topic Areas	Open-ended questions
Area 1: Understanding of attention	<ul style="list-style-type: none"> • When you hear the word ‘attention’, what do you think of? • How would you describe your own ‘attention’? <ul style="list-style-type: none"> ◦ If you take a minute to imagine your attention - how do you picture it? How would you describe it to other people? (sub-question) • How much do you agree with the other’s responses?
Area 2: The importance of attention	<ul style="list-style-type: none"> • How important do you think your ‘attention’ is? • Are there any aspects of your life where you feel your attention could be better? [or you need more attention?] • Do you associate levels of attention with health? This is a closed question so how about <ul style="list-style-type: none"> ◦ How would you associate attention with for example health, well-being, daily life etc...? (sub-question) • Are there any specific tasks where you feel that you need more attention? e.g. using different devices) • Sometimes we use the term attention in medical contexts – what do you think we mean by this? • Are there any circumstances where you think your attention is poor? Why? • How do you see ageing and your attention levels?’
Area 3: Changes in attention	<ul style="list-style-type: none"> • What are your personal experiences with attention? Have you noticed any change in your own attention with increasing age? • If you have experienced changes in your attention are there any tasks or specific circumstances which you used to find easy but are now more difficult? • Closing comments about the significance of attention in research in order to determine people’s responses.

RESULTS

A number of themes and sub-themes have been identified. The three major themes that emerged across both younger and older participant groups were ‘personal understanding of attention’, ‘attention is dependent on...’, and ‘impact of ageing’. Each theme and sub-theme is accompanied by participant responses quotations that most clearly represent it. Each quotation starts with a letter in brackets that is just a label for who said it. Also, for each theme there is a table illustrating the frequency by which each sub-theme was mentioned by the older and younger participants.

Personal Understanding of Attention

This theme represents the understanding both the older and younger participants had of ‘attention’. There are clear differences between what the older and younger groups believe attention is, but there are also some shared views. Figure 1 illustrates this theme. The first two sub-themes from the older adults (Figure 1) are ‘watching’ and ‘listening’, thus the participants expressed the view that attention is when someone is watching or listening to someone or something. For instance:

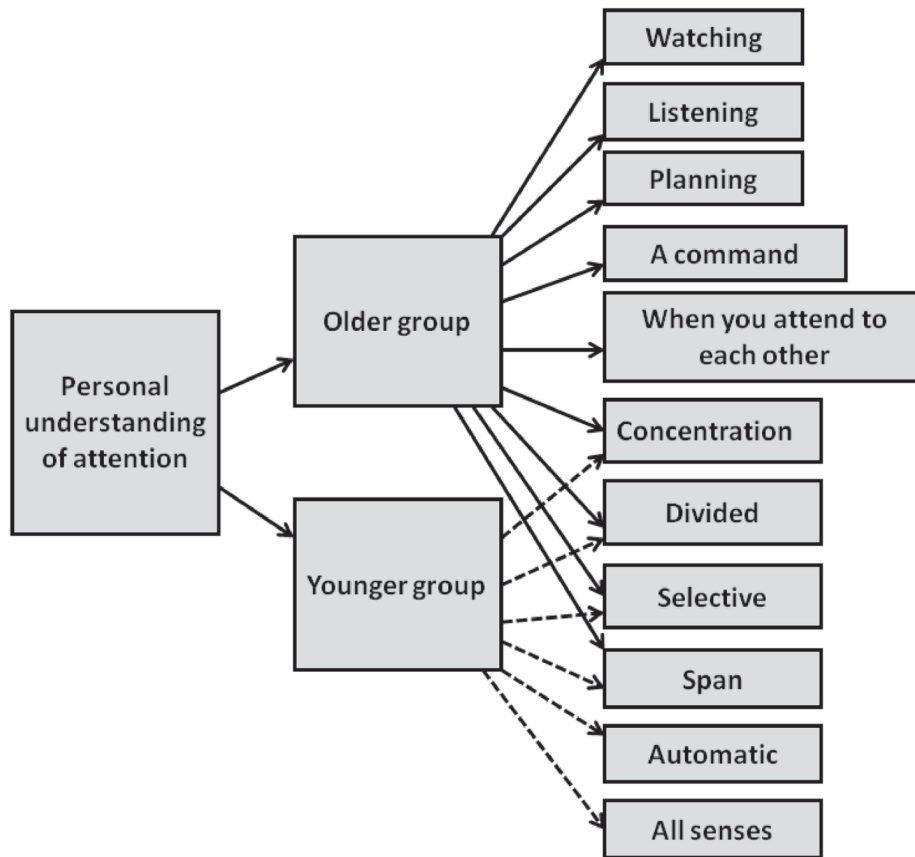
- *[J]: yeah I think I would say about listening. I realise how important it is and perhaps I don’t always listen well enough because my mind is drifting off.*

In contrast, the younger groups contributed to the development of the sub-theme ‘all senses’, thus they draw on all senses including touch, not just watching and listening. For instance:

- *[L]: taking in something, it’s not just listening to something it is all your senses really.*

The third sub-theme unique to the older participants is ‘planning’, thus referring to executive functioning (higher level of processing). For instance:

Figure 1. Personal understanding of attention



- [M]: *I suppose the other thing is like coming here this morning, like you pay attention to the timetable if you come on the bus and traffic if you have driven and you know you are supposed to be here by 10am and you're adjusting your timetable so that you are here in plenty of time. So you pay attention to that sort of thing. Now I came down through the park and I am sure that if anyone asked me 'how many people passed me with a dog?' I probably wouldn't be able to tell you. Several did but I wasn't counting, I was checking my watch and seeing how close I was to being where I should.*

Interestingly, a number of the older individuals thought of attention as being related to 'a command'. For instance:

- [J]: *immediately I think of 22 years spent in the army and someone giving you a command... attention!*
- [M]: I first heard a teacher saying 'pay attention'. I was one of those who were a chatterbox, and the 'pay attention' command.

In contrast, younger individuals viewed attention as being an 'automatic' process. For instance:

- [P]: I guess you're looking at basic skill acquisition there as well because I know when I was 17 I paid a lot more attention to what I was doing when I was driving about when I should be

changing gear, listening to the engine revs, looking at the other cars around you. But now it's more like an automatic response and an automatic process.

The final sub-theme unique to the older participants is 'when you attend to each other'. Fundamentally, this sub-theme relates to when an individual provides their attention to another. For instance:

- [R]: well how important would you say your attention is to you then? [G]: very. [M]: very. [A]: very. [JC]: to other people most certainly yes, it is almost like you're not paying respect to them. [G]: that's a good point. [J]: yes, absolutely. [A]: It is very important. I think you're right, I think it is almost as if you're not...I do know some people who disengage.

The four sub-themes that were developed from both age groups ('divided', 'selective', 'span', 'concentration') are fundamentally an accurate description of what attention is. Therefore, there was a consensus that attention can be divided between different stimuli, it can be selective and varies across a time span. However, 'concentration' was the sub-theme most frequently associated with attention. For instance:

Concentration (older group):

- [JC]: *yes I would follow that up absolutely. You said 'what first comes to mind' is my grandson the other day saying 'bampy you are not paying attention'. And he was quite right, I was concentrating on what I was wanting to do and he recognised I was not paying him enough attention or interest to what he wanted to communicate to me. Its interest, yes that is the word.*

Concentration (younger group):

- [S]: *yeah I agree with the working but in addition to these I work as [job name] so I have to do assessments and the person in front of me is talking and sometimes my mind wanders off. I have to call it back and say 'pay attention to what this person is saying because that is very important for you for later'. So especially if I am doing an assessment, there will be like my stuff I have to do, stuff I have to read, stuff they have to read, time I have to keep so when I have to do multiple things at a time I feel I need to concentrate a lot more because there is a greater likelihood that I am going to miss one or the other and maybe let them do the task not for one minute but for two minutes and that will mess it all up, so when I have to do loads of things.*

Table 2 shows that quotations relating to 'concentration' were mentioned much more by the older participants than the younger.

Attention is Dependent On...

Figure 2 illustrates four main themes concerning what 'attention is dependent on'. The four main themes are 'personal', 'poor attention', 'health', and 'stimuli'. Each theme and respective sub-themes will now be discussed. Table 3 also shows the frequency of quotations for each sub-theme across the two age groups.

Personal

There are six sub-themes within this theme (see Figure 2). The first sub-theme is unique to the older participants, thus they proposed that 'education, home upbringing, and social class' have a significant impact on attention. For instance:

Table 2. Personal understanding of attention - frequency of comments

Main theme	Sub-theme	Frequency older group	Frequency younger group
Personal understanding of attention	Watching	2	-
	Listening	3	-
	Planning	1	-
	A command	4	-
	When you attend to each other	12	-
	Concentration	14	5
	Divided	1	1
	Selective	14	5
	Span	6	5
	Automatic	2	-
	All senses	1	-

Figure 2. Attention is dependent on...

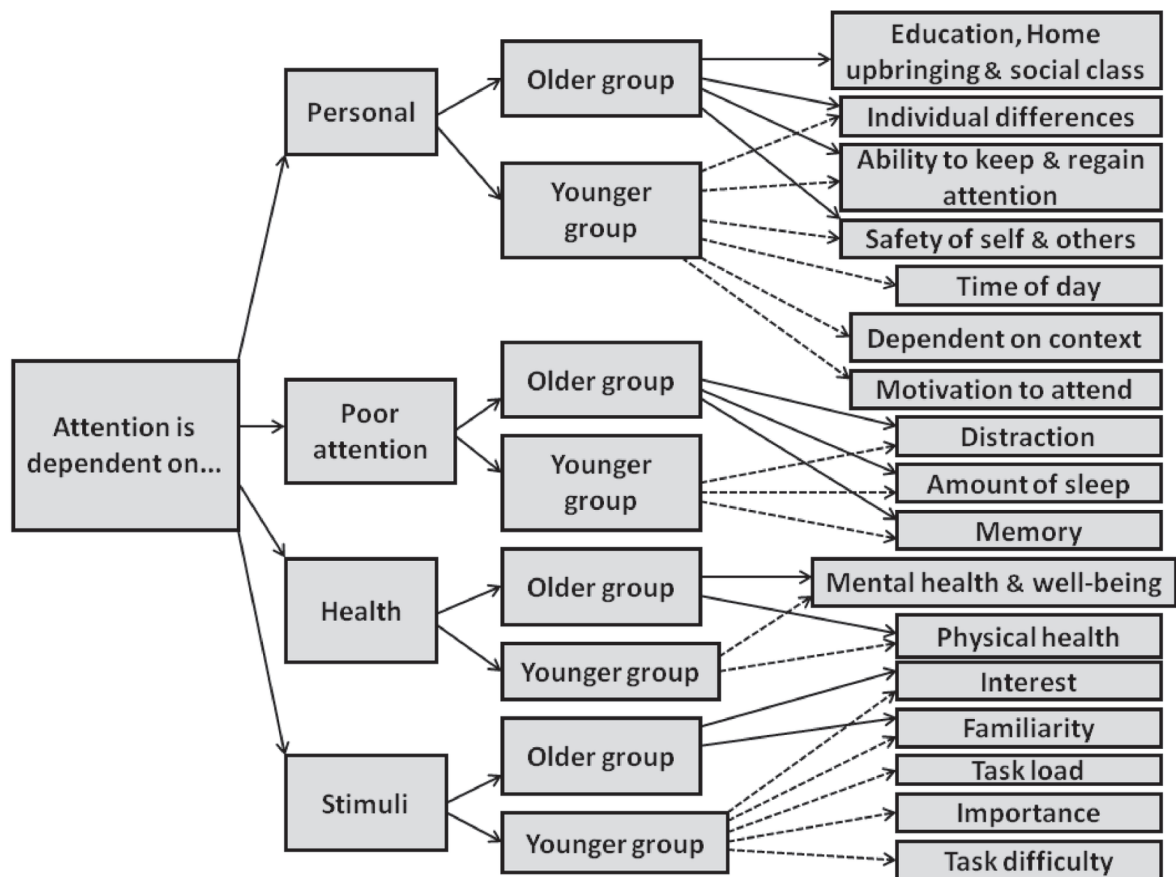


Table 3. Attention is dependent on - frequency of comments

	Main Theme	Sub-theme	Frequency Older Group	Frequency Younger Group
Attention is dependent on...	Personal	Education, home upbringing & social class	12	-
		Individual differences	6	3
		Ability to keep and regain attention	9	1
		Safety of self & others	7	4
		Time of day	-	5
		Dependent on context	-	3
		Motivation to attend	-	4
	Poor attention	Distraction	15	6
		Amount of sleep	5	7
		Memory	14	1
	Health	Mental health & well-being	4	2
		Physical health	7	5
	Stimuli	Interest	13	4
		Familiarity	1	3
		Task load	-	4
		Importance	-	6
		Task difficulty	-	2

- *[G]: classes are smaller, and this is what parents are paying for. It is almost like they are paying for a passport into something that is elevated beyond their background. [M]: it may be reinforced by the parent’s attention in the family, but it might also replace the parent’s attention if the parents are too busy with other things.*

Unique to the younger group in this theme was much more of a focus on influences in the present rather than the past, hence ‘time of day’, ‘context’, and ‘motivation to attend’. For instance:

Time of day:

- *[P]: I am better in the morning and awful in the afternoon. [R]: yeah definitely, time of day, tiredness, interest, how important the task is or whatever you’re attending to.*

Context:

- *[P]: yeah for me it is a super contextual thing. Like if I am reading a paper that takes more of a cognitive perspective then it is more difficult for me than if I am reading a paper that takes more of a health perspective or a social psychology perspective because that is what I am used to. So that sort of thing for me at least is extremely context dependent.*

Motivation to attend:

- *[L]: yeah motivation. [RB]: yeah sometimes it must feel like you have to make yourself attend to certain things.*

Three sub-themes in this theme were shared ideas from both the older and younger individuals. 'Individual differences' reflects the view that 'attention' is going to be different for each person. For instance:

Individual differences (older):

- *[G]: I think a lot of this is basic personality anyway. Just because one gets older you don't umm you don't have a personality transplant because you retire. Probably if you're organised at 15 you are going to be organised at 65. If you're laid back at 20...and you know a lot of it depends on like health, but life experiences and how the world has treated you and financial circumstances make it more comfortable. But I think peoples inherent personalities are always there you know.*

Individual differences (younger):

- *[P]: I think confidence comes in to that as well. [L]: confidence and experience then are key things I would have thought.*

'Ability to keep and regain attention' is the second shared sub-theme under the 'personal' theme. It reflects the skills, tactics, and external factors which both groups talked about regarding how they sustain their attention and draw it back when they lose it. For instance:

Ability to keep and regain attention (older):

- *[N]: if I think about something I need to do I have to do it immediately...I cannot pay attention for a long time; my memory just goes quickly.*

Ability to keep and regain attention (younger):

- *[A]: maybe when you're working. Instead of being overwhelmed regarding what I need to do, you just need to break it down so have like just do one thing at a time like do that, have a break, refresh, because I will then get more done.*

'Safety of self and others' reflects the view of both the older and younger participants that 'attention' is responsible for our safety and the safety of others. For instance:

Safety of self and others (older):

- *[P]: well I have a couple of times put some oil in a frying pan and standing there for it to heat up and then suddenly think 'oh!' remembering I have to do something and I have walked away, and then I have come back twice to find flames coming from it, no damage luckily.*

Safety of self and others (younger):

- *[R]: ... how important do you think your attention is? [L]: depends what you're doing, like if you're driving then that's really important or if it safety related then that is very important. [P]: again I think it goes back to task salience and um because for example you don't have to pay so much attention to making a coffee as you do when you're driving a car.*

Poor Attention

‘Poor attention’ is the second main theme relating to what attention is dependent on. There was a clear consensus between the younger and older groups regarding what influences attention. For instance, ‘poor attention’ being due to ‘distraction’, the ‘amount of sleep’ an individual has, and ‘memory’. First, ‘distraction’ reflects the views both age groups had of attention being affected by some form of internal or external distraction. For instance:

Distraction (older):

- *[J]: obviously when you are distracted by something that impacts on you umm if you are concentrating on whatever it is that you are trying to do at that minute then your attention while you’re doing that...well you haven’t got much attention to spare for whatever this other thing is it is going to affect you.*

Distraction (younger):

- *[B]: distractions. [R]: what type of distractions? [B]: where to start, this may sound trivial but if there is something I want to do after a task or if something is on my mind, like if you have heard something or you have read something then you just umm well it can just sometimes take over your attention.*

The second shared sub-theme is ‘amount of sleep’, thus poor attention is regarded as due to a lack of sleep. For instance:

Amount of sleep (older):

- *[P]: I have noticed that if I have not slept very well, and sometimes I don’t, my attention is not as good the next day. Fortunately I don’t have any specific health problems. I take blood pressure tablets but apart from that I am fine. A lack of sleep does it for me.*

Amount of sleep (younger):

- *[P]: yeah and I definitely notice a drop in my attention when I am tired. So like if I haven’t slept well the night before, or it is late in the evening or whatever, if I have had a really long and busy week when it comes to like the Thursday or Friday I will purposely pick tasks that I know for example data analysis where I am just like plugging things into the computer.*

The final shared sub-theme under the theme ‘poor attention’ is ‘memory’. Therefore, both age groups viewed poor attention as being related to memory. For instance:

Memory (older):

- *[N]: if I go to get something from the fridge, I am very disappointed how often “why am I over here? I can’t remember why I have come over here, was it the fridge? Toilet?” trying to remember why I was walking in that direction.*

Memory (younger):

- *[S]: we all know that it is going to go away as we age, it’s like almost inevitable. But what I always wonder is to what degree that is ok, to what degree is that normal, to what degree does it mean something else. For example, when I speak to my grandmother I sometimes notice things that*

she forgets to do. I can see that her attention is slipping away...so maybe it is more important to be aware of it that it is going away and therefore adapting your tasks to your level.

Table 3 shows a large difference in the frequency of quotations relating to memory between the older and younger participants. The older participants referred to memory 14 times and the younger participants only referred to it once.

Health

The third main theme under ‘attention is dependent on’ is ‘health’. Thus, attention was deemed to be influenced by the sub-themes ‘mental health and well-being’ and ‘physical health’. Both sub-themes were independently shared by both older and younger participants. For instance:

Mental health and well-being (older):

- “[M]: it was in an article this weekend about whether or not Seb Coe should be one of the candidates for the BBC Chairman job, and one of the points that he made was that if you don’t keep yourself fit and healthy, and keep active then your attention to issues and problems that come up in whatever task you take on is much much diminished. And you know we know there is an issue with keeping physically active and depression you know, but if you do keep physically active then the depression is likely to be less”.

Mental health and well-being (younger):

- [C]: yeah and worries, like I have worries now that I have never had before and even when I am consciously trying to attend to something now at [age] I will find my mind wandering over worries and things. That definitely affects attention so I don’t think it is necessarily just a cognitive thing but it can be an emotional, psychological thing as well. And I guess as you get older you have got health worries and that can well as much as that can take your attention away from things I think it can make you attenuate to things which might not necessarily need attenuating to.

Physical health (older):

- [N]: I am pretty certain that if someone has got tooth ache, or ear ache or head ache or something, it is distracting and they are less able to pay attention for any length of time.

Physical health (younger):

- [P]: well that is the neurophysiological side but even down to the most basic forms that if you’re experiencing pain in any way shape or form that distracts from whatever information you’re trying to process.

Stimuli

The final main theme in Figure 2 is ‘stimuli’, thus attention is dependent on certain factors relating to particular stimuli. Attention was considered to be dependent on stimuli ‘interest’ and ‘familiarity’ in both the older and younger groups. For instance:

Interest (older group):

- [A]: I find that you have got to be interested in something. If I am not interested in something then I just switch off. Umm so to me attention is connected to interest.

Interest (younger group):

- *[C]: yeah I think so, like now I am doing my PhD so my attention is focused more like if I hear the news I will attend to things that will trigger something to do with my course or well I have a child so to something to do with children so yeah it is things that interest me whereas before maybe I was a lot more general.*

Familiarity (older group):

- *[R]: I am intrigued, when talking about different countries and going travelling etc...Do you think there is a link between familiarity and attention? [J]: yes definitely. [RA]: well I can get lost in (local area); I don't have to go abroad. [R]: have you always been like that? [RA]: no. [R]: ok. [RA]: I just couldn't think of the route there. I thought oh come on now brain; you have been here millions of times!*

Familiarity (younger group):

- *[A]: yeah I suppose like moving to manual cars, like at first it is all alien and you need to learn the routine and how everything works. Slowly things will become a bit more automatic so you don't have to attend to it so much*

Unique to the younger group they also referred to 'task load', task 'importance' and 'task difficulty' as having an impact on attention. For instance:

Task load:

- *[C]: yeah it's like task load as well isn't it so as you get older I think there are certain times in your life the tasks that you are having to attend to might involve more. And I guess as you get older you know it is a part of neurodegeneration so it is not necessarily well it is your attention but is your attention affected because of the task load? As opposed to um well I see my mother now...she can cope with and maybe a meal that she has cooked a thousand times but then you ask her to do a meal out of a recipe book that maybe takes more time because she is learning while doing the task and then something else comes into it well the task load and the load on your attention increases you know she crumbles [laughter].*

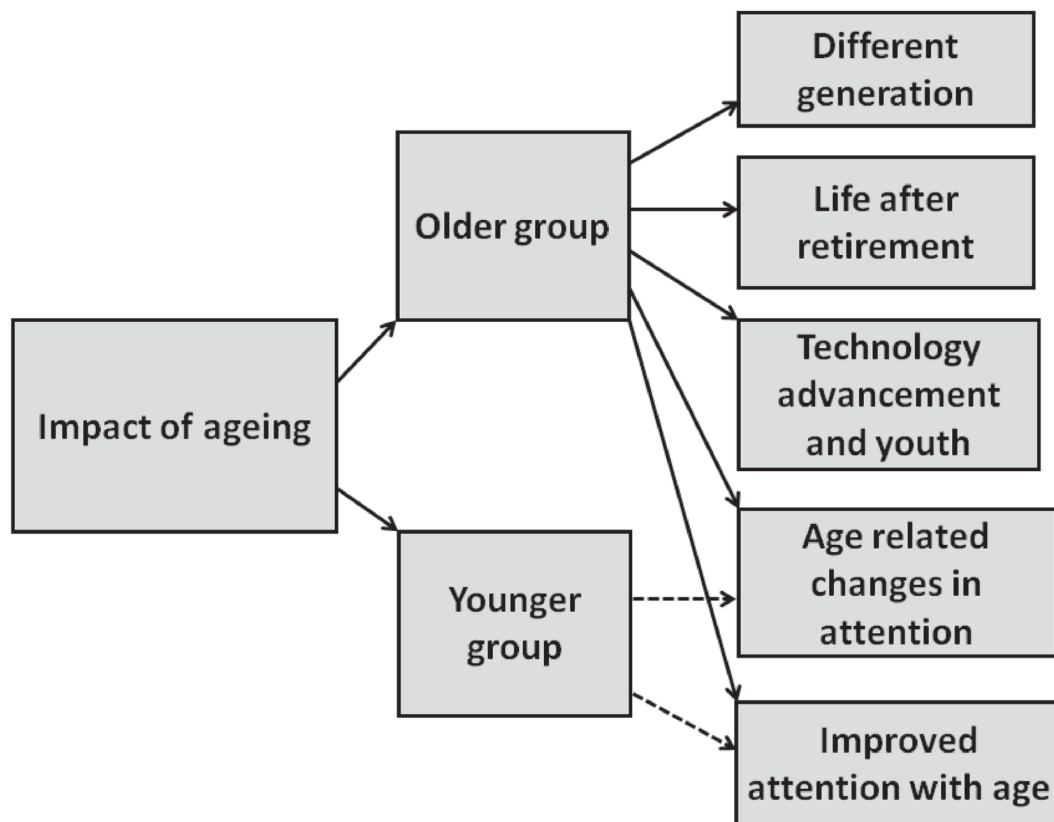
Importance:

- *[B]: I think it depends on what you are doing at the time. It is important to pay attention when you're driving, it not so important when you wander off from writing as you can go back to it later. [P]: I think it is more important if you want to get a task done quickly and in an efficient manner. Yeah like it doesn't matter if you don't care about the quality of the task.*

Task difficulty:

- *[P]: I have to agree. It happens to me when I am sitting down to write or if I have to read a lot of articles, especially really really long ones, to be able to like keep the focus especially if they are in depth or taking a slightly different perspective to what I am used to reading and it is not my strength to try and pay attention and take in the article I struggle sometimes. Like I will have to go back to go back and re-read some articles.*

Figure 3. Impact of ageing



Impact of Ageing

The third major theme identified was the ‘impact of ageing’, thus the impact ageing has on attention (see Figure 3). All five sub-themes were derived from the older participants’ responses with the younger participants being in agreement with ‘age related changes in attention’ and ‘improved attention with age’. The three sub-themes unique to the older participants undoubtedly reflect their age in comparison to the younger generation. Table 4 also shows how frequently each sub-theme was mentioned by both the older and younger participants.

First, the sub-theme ‘different generation’ reflects the older participants’ view that attention is very different between the older and younger generations. For instance:

Different generation:

- *...children now have so much information available to them now that we didn't have but that they don't know how to process it. They should be able to be 'adult' much earlier but they are not, they don't appear to be any more adult than we were at their age. Well I got married at [age], I got a house, and a mortgage etc. and you take on huge responsibilities straight away and you think that children these days can cope those sorts of things really easily but they don't seem to be. They say it is due to the overload of information coming in and they just can't process it.*

Second, the sub-theme ‘life after retirement’ reflects how the older participants felt their attention is different now after retirement compared to when they were working full time. For instance:

Life after retirement:

Table 4. Impact of ageing - frequency of comments

Main Theme	Sub-Theme	Frequency Older Group	Frequency Younger Group
Impact of ageing	Different generation	4	-
	Life after retirement	2	-
	Technology advancement and youth	3	-
	Age related changes in attention	11	4
	Improved attention with age	2	1

- *[JC]: yes like you prioritise, you are selective in your attention. Can I just digress, I think the best period I had was about 10 years ago when I was semi-retired, I was well over 65 but the firm I worked for said ‘well look we still want you to do this so I was going in two or three times a week’. Now that provided a structure to the week but the interesting thing is, not only did it force me to pay attention and prioritise my working day, it meant that because I had quite unlimited time I prioritised and paid attention better in my own so called ‘free time’. It was an interesting balance that.*

The final sub-theme unique to the older participants is ‘technology advancement and youth’, thus reflecting the relationship between the advancement of technology and ageing. For instance:
 Tech advancement and youth:

- *[J]: I suppose there is technology isn’t there, they have been brought up in a totally different technological age and that must have some relationship to attention. I mean kids playing with all these computer games; I have never played a computer game.*

The final two sub-themes relating to the ‘impact of ageing’ were developed as shared views from both the older and younger participants. First, the sub-theme ‘age related changes in attention’ reflects how both groups think attention changes with age across the lifespan. For instance:

Age related changes in attention (older group):

- *[R]: yes. Fab ok, so how would you describe your own attention? [P]: diminishing. [R]: ok, how would you say that? [P]: well I am not sure if it is quite the same thing but I do find if I am doing something now I have to concentrate on that whatever it is I am doing. Whereas before I was able to multi-task, now if I don’t pay attention to what I am doing I do it wrong.*

Age related changes in attention (younger group):

- *[C]: I see it as on two ends of a spectrum so like the very young like their attention span is kind of short lived and again it is only what interests them, that’s children. And then you go to the other end of the spectrum as you get older it goes to the same, it’s like children they can only take in so much and they are so busy but whereas at the other end of the spectrum they just seem to attend to what interests them and what they know because maybe everything else is a bit too much for them with I don’t know with normal ageing decline and things like that.*

The last sub-theme with a shared view from both groups reflects the positive view of attention improving with age. For instance:

Improved attention with age (older group):

- *[J]: Well I don't think they are quite the same see, because I think I can concentrate very well like if I start a cross word or something you know I have got to finish it, I will spend days on it if necessary or I can do a particular piece of work and focus on it but I don't feel it's quite the same as attention.*

Improved attention with age (younger group):

- *[B]: I think it matters at different stages in your life as well. Like a two year old, the expectation of them being able to concentrate for an hour is just non-existent. But when you're in a degree and you're sitting in lectures you're meant to concentrate.*

DISCUSSION

The aim of this research was to explore the understanding older members of the general public had of 'attention', and how their views compared to those of younger adults. Such knowledge would highlight whether they understand and communicate about attention per se or any influences upon it, in the same way as mobile device developers do. The results would also be expected to highlight shared areas of understanding between the older and younger adults.

The themes and relevant sub-themes identified in this study have provided an insight into the diverse understanding of attention in both older and younger adults. Some of the sub-themes identified demonstrate that both age groups have similar understanding of what attention is. For instance, both groups contributed to the development of sub-themes 'span', 'selective', and 'divided', thus concurring with what is understood by attention in academia and device development. Secondly, both age groups expressed that their attention is dependent on, for instance, the amount of sleep they have had, if they are distracted, or if they are feeling unwell. Such examples indicate that both age groups have a reasonable understanding of what attention is in both personal and general terms.

It is also interesting to note that the understanding of the causes of poor attention and the impact of health upon attention were shared between groups. This agrees with our observation in the introduction, i.e. younger designers tend to have some awareness of the possibility that attention diminishes because of some health problems associated with ageing and mobile designers tend to be aware of environmental distractions such as changes in the environment.

Design Implications of Differences between Older and Younger Adults

We have argued that a critical element of mobile design is often overlooked when trying to understand the disconnectedness observed between older adults and their devices: namely attention-related differences between designers and older users. Other well regarded work in this area suggests this disconnect can be widely observed and arises because the designers are themselves typically younger adults who struggle to view their designs from the perspective of older adults (Gregor, Newell, & Zajicek, 2002; Newell & Gregor, 2000; Pullin & Newell, 2007). In this work, we have shown that what younger and older adults intuitively understand by attention does differ in some respects. User engagement and feedback is critical to overcoming this gulf between perspectives but, even then, if typically younger adults', understanding of what an older user means, or experiences, in terms of "attention" is different to what the older user intends this method might fall short. To illustrate this issue, we look at some implications from our work for a designer who we assume is younger working with older adults and see where these issues might be found in existing work. While we do not suggest that these are absolute rules that apply to all developers and designers, the concepts and scenarios might still prove relevant for many.

Younger adults in particular identified readily with the idea of selective or divided attention. They reported being able to split their attention between multiple external sources or multi-task and talked more about their attention being “demanded” by something. In comparison, older adults talked about the improvement in terms of ability to focus on tasks that came with ageing, both in the small scale sense of focusing on a task while ignoring distractions in their immediate environment, and in the wide scale when choosing what aspects of their life they wanted to focus their attention on. This mirrors the idea of *exogenously* captured attention in psychology (where an external source captures ones attention) and *endogenous* attention (controlling what you focus on internally). This concept is also sometimes referred to as *selective* attention (Posner & Peterson, 1990; Desimone & Duncan, 1995) and some of our older participants even used this term, saying they had the capacity to select what they were attentive to. Furthermore, the younger participants related to attention more in the present here and now. They focused much more on, for instance, how the time of day, task load, task importance, and task difficulty all impact upon their attention. The older participants however, focused much more on attention being related to their past experiences.

From the perspective of the designer, who we characterise here as being similar to our younger adults in relation to this study, such beliefs might mean that they are inclined to develop interfaces that demand their user’s attention whereas, in contrast, older adults would place value on having the ability to ignore their devices. The younger designer’s attitude would seem to be a good fit for the way that instant messenger or email services function and are used on mobile phones – the constant push of messages to the user and their alerts serving to demand attention. While this might appeal to younger adults who can direct their attention more easily, older adults who value their ability to select the focus of their attention might come to resent such systems and services making demands of them. Indeed, we see that older adults have been disparaging of such systems in previous research (Lindsay et al, 2012; Pullin & Newell, 2007) and in our focus groups we saw blame attributed to mobile phones for causing deficits in the attention of younger adults by the older group. In the authors’ previous design work (Lindsay et al, 2012), we have seen older adults refer disparagingly to the way that younger people use their mobile phones and allow themselves to become distracted by them all the time. For instance, “...they don’t need to know 8x9 because they have got a machine which will do it instantly for them in any case so why bother. And therefore they probably the amount of information that they are subconsciously keeping could be quite small in comparison because all of this stuff is available instantly which wasn’t for us, we would have to go the library and look up books and talk to people”.

However, it is important to not simply frame the ageing process as something that negatively impacts upon attention. Another difference was that older adults seemed to have a more nuanced understanding of their own attention with more complex associations with what it was and what it was dependent upon. This might be due to an increased level of exertion required to give attention as they age or possibly concern about their increased propensity for cognitive decline. Alternatively, it may simply be an artefact of possessing greater amounts of lived experience. Awareness of the age-related increase in the negative consequences of attentional or cognitive deficit, such as disorientation, getting lost, diminished driving skills and many other activities of daily living, might focus older adults on their own cognitive ability. Whatever the motivation for this more nuanced understanding, it seems clear that older adults take some pride in their ability to selectively focus attention. Devices that do not fit within their current approach to, and understanding of, attention or focused work could easily become resented.

A cautionary scenario for designers considering how to develop systems for older adults relates to the pride that older adults may take in their capacity to simply ignore things or not be distracted by exogenous factors: “*If I am not interested in something then I just switch off*”. Systems or devices that are built for them but which do not prove themselves to be useful, while coming with some demand on attention such as a mobile instant messenger client, could fall foul of their users’ selective attention and be ignored. In contrast, a younger user would experience less impact from demands for attention

and might be more willing to give the new device time to become more interesting or relevant. The widely used Technology Acceptance Model (TAM) attempts to show how people specifically evaluate whether to use a new piece of technology. When the emphasis has been placed on how the TAM relates to older adults' acceptance, compared to that of younger adults', they have been found to give a stronger than average weighting to the 'perceived usefulness' of a device (McCloskey, 2006) and have a stronger than average aversion to anything they perceived as 'behavioural control' or loss of autonomy coming from the device (Morris & Venkatesh, 2000). To put this in simpler terms, the older adults were particularly concerned with the usefulness of any new device as opposed to how fun or novel they thought it was and were particularly averse to any new technology that tried to make them change the way they behave. These attempts to apply TAM to an older population suggested that some of these observed differences might stem from cognitive impediment or memory problems, however, the emphasis on behavioural control is perhaps better explained in light of the differences in attitudes and understanding of attention highlighted in this study. Older adults in our study valued the ability to choose how they directed their attention and so any new device that demands attention from them directly attacks this.

In addition, if the more nuanced understanding of attention shown by the older adults reflects a concern over the possibility of experiencing cognitive impairment, failures arising from unsuitable design when interacting with a device could lead an older adult to question their own cognitive wellbeing, making interacting with the device an extremely unpleasant experience. In previous work we have observed that older adults had a particular contempt for technology that made them "feel" disabled (Lindsay et al, 2012).

There was also a sense that poor attention was attributed in many instances to modern technology. For example, the use of mobile phones was viewed as an impediment to attention by one group when playing games in public was discussed. This wariness of a possible link between technology and impaired attention is another barrier that designers need to consider addressing in their work. Can a mobile phone augment rather than impair an older person's capacity to attend to the environment? Could the context aware nature of the mobile device, for example, allow a user to direct their attention to the world around them and perhaps supplement that experience through the provision of new information about the things they see?

The discussion has also highlighted the fact that for older users there are a number of factors that affect their attention which do not seem to affect that of younger adults. The feeling was that younger adults had a greater capacity to deal with distraction (Wais & Gazzaley, 2014) that would appear to link in to the concept of inhibitory processing found in psychology literature (Guerreiro, Murphy, & Van Gerven, 2010). Related to this is that younger adults seemed to have better visual attention in general with wider fields of view whereas for older adults, visual decline and challenges wearing varifocal lenses were reported; factors which were noted as particularly problematic when shifting focus. This issue also seems to resonate with literature on the subject of interface design for older adults. Time and again when work is done with older adults, we see user interfaces criticised for the presence of distracting information (Hart, Chaparro, & Halcomb, 2008), overlays (Rice & Alm, 2008) or clutter (Nahm, Preece, Resnick, & Mills, 2004) that go uncommented on with younger users.

Differences between Psychological Models and Public Concepts

There were a number of themes and sub-themes that were unveiled in the process that did not fit the academic research-based concept and understanding of attention. For instance, the older adults focused very much on the relationship between attention and life in general, particularly in relation to their own experience, especially the past, e.g., past education, social class, and upbringing. In addition they frequently related attention to the armed forces' command of "attention!" This study reveals that the methodological practices of academic researchers, along with the associated assumptions of designers who have taken the time to research cognitive decline and attention, need refining in order to ensure improved ecological validity. We also acknowledge that participants' personality

such as being a natural ‘multi-tasker’ or being patient and a meditator can have an effect in their interpretation of attention. Likewise, participants’ background and educational level can be a factor in doing both qualitative and quantitative studies on attention. Therefore factors such these will be queried in future research.

CONCLUSION AND FUTURE WORK

This study highlights the fact that the concept of attention is not uniformly understood by older adults, designers or academics. Older and younger people do not spontaneously use the same terminology or associate the same characteristics to the terms they share. For designers, the implication is that their own assumptions about attention need to be questioned. There are parallels between this and the challenges that designers faced previously, i.e., stepping away from their assumptions about how users would interact with a device. This was addressed through User Centred Design approaches that allowed designers to identify their own assumptions and biases through interacting with their users at length. Perhaps there is a need for something similar with respect to ageing, attention and cognition? In the meantime, when questions about interaction relate to attention and cognition, it is worth encouraging designers to be explicit about what it is they mean when they talk about attention with older users, and to be attentive to the terms participants use to describe experiences. Therefore, one should not just simply ask for a person’s judgement on how they found their attention, but instead ask specific questions related to the device itself, its design, and were people focusing their attention on working out how to hold, use or even see a device and respond, thus reducing the resources available for doing the actual task?

It is important to note that the topic of attention in relation to the design of digital technologies and in particular handheld devices, should be a two-way communication. This qualitative research is a stepping-stone to open a dialogue in Mobile HCI and other areas related to design on this very important and widely neglected topic. As the next step the authors of this paper would like to open up this dialogue with developers and designers of interfaces on handheld devices.

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