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Designing for older people: But who is an older person?

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Abstract: This paper explores a critical aspect of designing for older people. It argues that we need a clear description of who is "an older person". Or, when a person starts being old from middle age. Research has well established that there is greater variability in abilities among older than among younger people. This often creates problems in designing intuitive product interfaces for this target group. Intuitive design is basically about developing interfaces that reflect target users' familiarity. However, when the target group are very diverse in their capabilities and familiarity it makes is extremely difficult to design intuitive interfaces.

Our research suggests that the main reason for this predicament is due to excessive focus on chronological ageing. And, if we look at a target group based more on their cognitive abilities instead- it will provide us much more effective approach in dealing with this problem.

Keywords: intuitive design; older people; cognitive ageing; inclusive design

1. Introduction

The intuitive use of an interface involves subconscious use of users' prior knowledge. Thus, design for intuitive use basically involves two steps: 1) to understand domain-specific prior experience of the user; and 2) to design interfaces that reflect this prior experience. In reality, however, research shows that it is much more complex to implement this framework (Blackler, 2008; Hurtienne, Weber, & Blessing, 2008). To start with, investigating what target users are familiar with is a very resource intensive process, both in terms of time and money (Spool, 2005). In addition, no two users share similar prior knowledge. Especially so if the target group is older people, who are lot more diverse both in terms of their prior knowledge and capabilities.

This paper will discuss a way to address this issue based on a study that investigated redundancy as one of the strategies that could bridge the variability in older people's capabilities, and help them use complex technological devices intuitively. This study was specifically designed to investigate age differences from the perspectives of both chronological age and cognitive abilities.

2. Diversity

There are many reasons behind older people being deficient in prior knowledge and more varied in their capabilities. For example, age-related cognitive degradation (Langdon, Lewis, & Clarkson, 2007; Lim, 2009), low perceived self-efficacy (Bandura, Freeman, & Lightsey, 1999; Czaja & Lee, 2007) and cohort effects (Docampo Rama, Ridder, & Bouma, 2001; Lim, 2009).

As people age, they tend to specialise in an area of their choice. Their other interests also tend to become more focused. Each individual has different needs, professions and interests, and this brings about the variability in older people (Salthouse, 2010) . Older people are also slow in adopting new technologies, as they do not see a need to keep up with technology for the sake of doing so. However, where they see a need, they do embrace the technology without reservations (Czaja & Lee, 2007). Finally, age-related cognitive decline slows down acquisition of new knowledge (Bäckman, Small, & Wahlin, 2001). The awareness of this limitation probably also compels older people to be more selective in determining what they should learn.

These and other related factors results in two issues regarding domain-specific prior knowledge in older people: 1) the variability in their knowledge and 2) knowledge that is not in pace with contemporary technology.

3. Ageing and cognitive processing

The process of ageing leads to decline in cognitive skills, which in turn affects learning of new information. Some research points out that this decline is not global or linear, as not all skills are affected with ageing (Bäckman et al., 2001). There is ample evidence that age-related memory impairment varies greatly between individuals. Memory is broadly categorised into two systems: 1. Short-term or Working Memory and, 2. Long-term Memory. Of these two, Working Memory is most affected by age-related degradation.

Working Memory is not a unitary system. Baddeley and Hitch (1974) proposed a multiple component system that emphasised functional importance rather than just storage. This system comprises of three components (later expanded to four), the Phonological loop, the Visuospatial sketchpad, the Central Executive and the most recent addition the Episodic buffer (Baddeley, 2002). The Central Executive is engaged in reasoning, decision-making and co-ordinating the activities of other subsidiary systems. In general, Working Memory function deteriorates with ageing. Moreover, age-related Working Memory deficiencies becomes more prominent as the complexity of cognitive tasks increases, such as when a task requires simultaneous storage and processing of information (Bäckman et al., 2001). Salthouse and Babcock (1991) found that ageing related decline in Working Memory is mostly due to slowing down of the Central Executive component. However, manifestation of Working Memory deficiencies in ageing is often mediated by coping mechanisms adopted by older individuals (Brébion, Smith, & Ehrlich, 1997).

3.1. Attention and ageing

A variety of behavioral inefficiencies are attributed to age-related changes in attention. In general, attentional capacity is conceptualised as limited supply of energy that supports cognitive processing. The Central Executive is thought to play a key role in directing and controlling attention (Baddeley, 2002; Norman & Shallice, 2000). Attention is a term used to describe a variety of cognitive functions. It is usually defined in literature by its various functions. For example, “Selective-attention” is processing of one source of information at the expense of other, “Divided-attention” is simultaneous processing of two or more sources of information, “Switching-attention” is alternatively processing one source then other, and “Sustained-attention” is maintaining a consistent focus on one source (McDowd & Shaw, 2000). However, this is a framework used to organise and present information in reporting literature on attention. In reality, complex tasks require more than one attentional function for cognitive processing.

Age-related decline is most noticeable in Selective-attention and Divided-attention functions. Selective-attention, the ability to attend selectively to relevant information and ignore irrelevant information, is considered a prerequisite for extracting relevant information from distracting or irrelevant detail (Kramer & Madden, 2008; McDowd & Shaw, 2000). Some researchers argue that age-related decline in selective-attention is due to the inability of older people to inhibit task irrelevant information (Hasher & Zacks, 1988; Morrison, 2005).

4. Experiment design

This experiment was designed to investigate if redundancy in interface design facilitates intuitive use in older users and users with low technological prior experience. Redundancy refers to a repetition of content in different format. The repetition has to be in an alternative physical form, for example, voice and text or picture and text (Wickens, Lee, Liu, & Becker, 2004). This experiment used a cross-sectional, between-groups matched-subject design. Participants for this experiment were recruited from various organisations (like, sports clubs, educational institutes, recreational facilities and retirement resorts). Overall 50 participants between ages 18 to 83 participated in this study.

4.1. Apparatus and measures

This experiment used a virtual version of commercially available body fat analyser (**Error! Reference source not found.**) for the trials. This research utilised multiple data collection methods. These were verbal protocol, observation of task performance, interviews and rating scale questionnaire and cognitive measures tasks.

Figure 1: Virtual body fat analyser device with modified interface and controls to represent Redundant interface

Technology prior-experience was captured using a two part questionnaire. Cognitive abilities of the users were captured using CogLab. CogLab is a cognitive measures software (Blackler, Mahar, & Popovic, 2010) that administers various instruments that measure different aspects of cognitive function. For this experiment following instruments were used.

Corsi-span and Digit-span: Measure of visual sketchpad and phonological loop capacity. A standard Corsi Span task was used where participants viewed sets of squares on the screen that recalled their location by button click. The number of squares presented was varied using a staircase procedure to find the participants visual span. Similarly, Digit Span was measured by presenting lists of digits one at a time on the screen. Participants recalled the lists by clicking on a number pad on the screen. Again a staircase procedure was used to very the list length.

Visual and Phonological transform task: Measure of Central Executive capacity to manipulate spatial and phonological information. In the Phonological transform task participants viewed a set of 4 numbers then were required to move each number forward by 4 places (e.g. 5 would become 9). Similarly, in Visual transform task participants viewed a pattern of 4 dots on a disk then were required to rotate them 4 places in clockwise direction.

Go/No-Go task: Sustained attention and response inhibition. This instrument was also used to measure Choice Reaction Time of participants. In Go/No-go (Nielson, Langenecker, & Garavan, 2002) task participants viewed individual alphabets serially on the screen and are required to respond to stipulated targets. There are 3 sets of trials in this task. First set: they are required to respond, by clicking a button, when ever they see specific alphabets (X,Y and Z), second set: they are required to respond to only alternating target letters (X, Y, X, Y) and in the third set: participants are required to respond to three alternating target letters (X, Y, X, Z, Y, Z).

The data from Noldus Observer, Technology prior-experience questionnaires and Cognitive Measures software were exported into SPSS for statistical analysis.

5. Summary of findings

The outcomes of this study have highlighted that older age groups, when compared with younger age groups, are very diverse in their capabilities in terms of technology prior experience and cognitive functioning. As can be seen in Figure 2 shows the variability in *time to complete the task* increases with *age*, with the younger group being more homogeneous than the older age group.

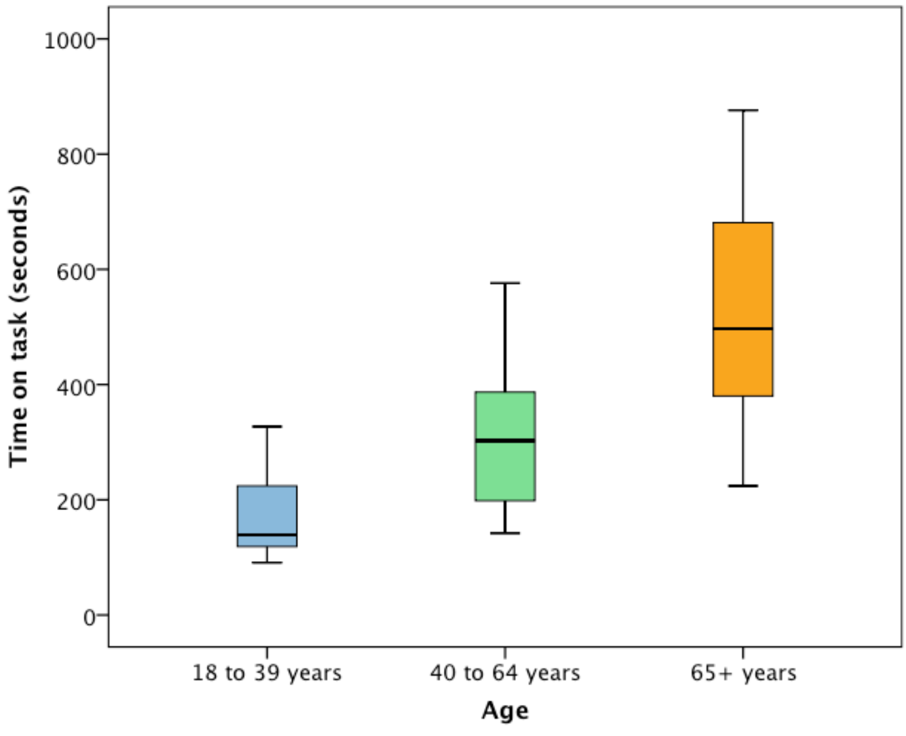

Figure 2: : Box plots for time on task by three age groups

Most importantly, contrary to what was hypothesised, older participants (65+) were significantly faster on the text-based interface when compared to the redundant and symbols-only interfaces. We were expecting a redundant interface to be more beneficial for older people. However, the text based interface turned out to be much more intuitive, faster and less prone to errors for older users and users with low domain-specific prior experience.

Most importantly, there were no differences between young and older age groups in terms of errors on a text-based interface.

This finding has shifted our focus to cognitive data to understand the underlying reason for these unexpected results. One of the reasons that emerged was that this could be due to age related degradation in visual information processing, as both symbols-based and redundant interfaces are visually more complex to process compared to text-based interface. In addition, it also provided us insight into how we could address the diversity in older age groups.

6. Chronological age versus cognitive age

Once we examine cognitive abilities against chronological age it gives a clear indication that age related cognitive decline is not liner nor consistent. For example, sustained attention is a good indicator for cognitive ageing/capability of a person. And as can be seen in Figure 3 it does not decline linearly with age. The higher number on sustained attention is an indicator for normal functioning. The question this raises is “at what range of cognitive ability a person is considered young, middle and old?” The scatter plot clearly shows the irrelevance of chorological age as an indicator of capability.

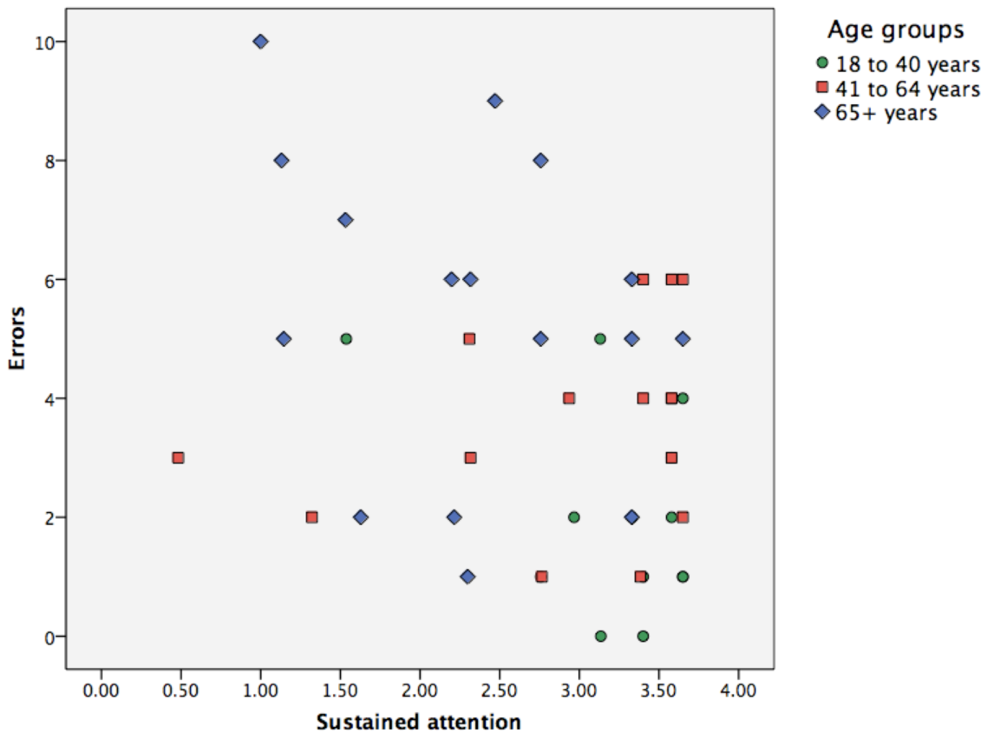

Figure 3: Sustained attention errors

The scatter plot for different functions of central executive plotted against age shows similar trends. As can be seen in **Error! Reference source not found.** , visuospatial sketchpad capacity (Corsispan) declines with age in a linear fashion but it is not universal. Phonological transform response time (PhonologicaltranformRT) increase with age, and its variability also increases as age progresses. On the other hand, sustained attention (pgng2d) decline is a little more varied. Both transformation response time and attention are functions of central executive. This shows that age-related cognitive decline is not linear, and it not only varies from person to person but also between different cognitive functions.

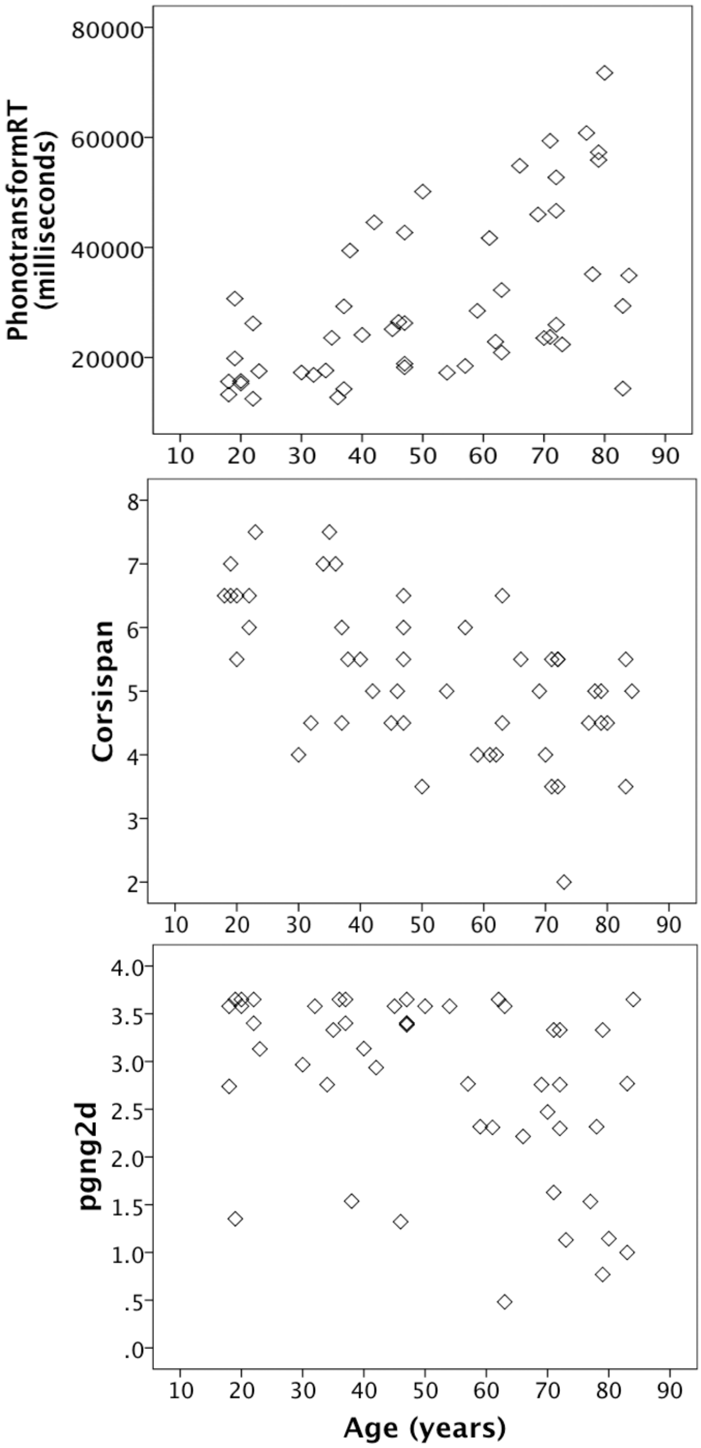

Figure 4: Performance on cognitive tasks and chronological age

The advantage of this data is that it provides us an insight into behaviour of a user on an interface. For example, visuospatial sketchpad capacity correlates with use of visually intensive interfaced design. Sustained attention correlates with errors and ability to recover from errors.

6.1. Age, technology prior experience and cognitive ability

Interestingly, we also realised why prior knowledge alone is not a good indicator of users' capabilities. The core of any "user centric design" or "design for intuitive use" process is to match a user's prior knowledge to functions and features of an interface design. However, it should be noted that cognitive ability plays a mediator role in the relationship between age, technology prior experience and performance on various tasks. For example, scatter plots (Figure 5) of time *on task*, technology prior experience (TP), *age* and *sustained attention* from the Experiment 1 data clearly show that, although some cases scored high on the TP (for example, case 37 in the plots; red arrow), they took more time on the task. However, as can be seen in the second plot, their score for sustained attention is low. In some cases, it is the reverse (for example, case 2 in the plots; green arrow); they scored low on TP, high on sustained attention and took less time on task. This data suggests that cognitive ability is a mediating variable for *the time on task* and *prior experience* relationship.

Cognitive capability, especially central executive function, plays a crucial role not only in the retrieval and processing of information from long-term memory, but also in acquiring this information (Langdon, Lewis, & Clarkson, 2010; Lim, 2009). In short, both cognitive abilities and domain-specific prior knowledge are essential for successful use of product interfaces. Cognitive ability influences retrieval and application of relevant knowledge. It is also essential for efficiently learning unfamiliar features in the interface.

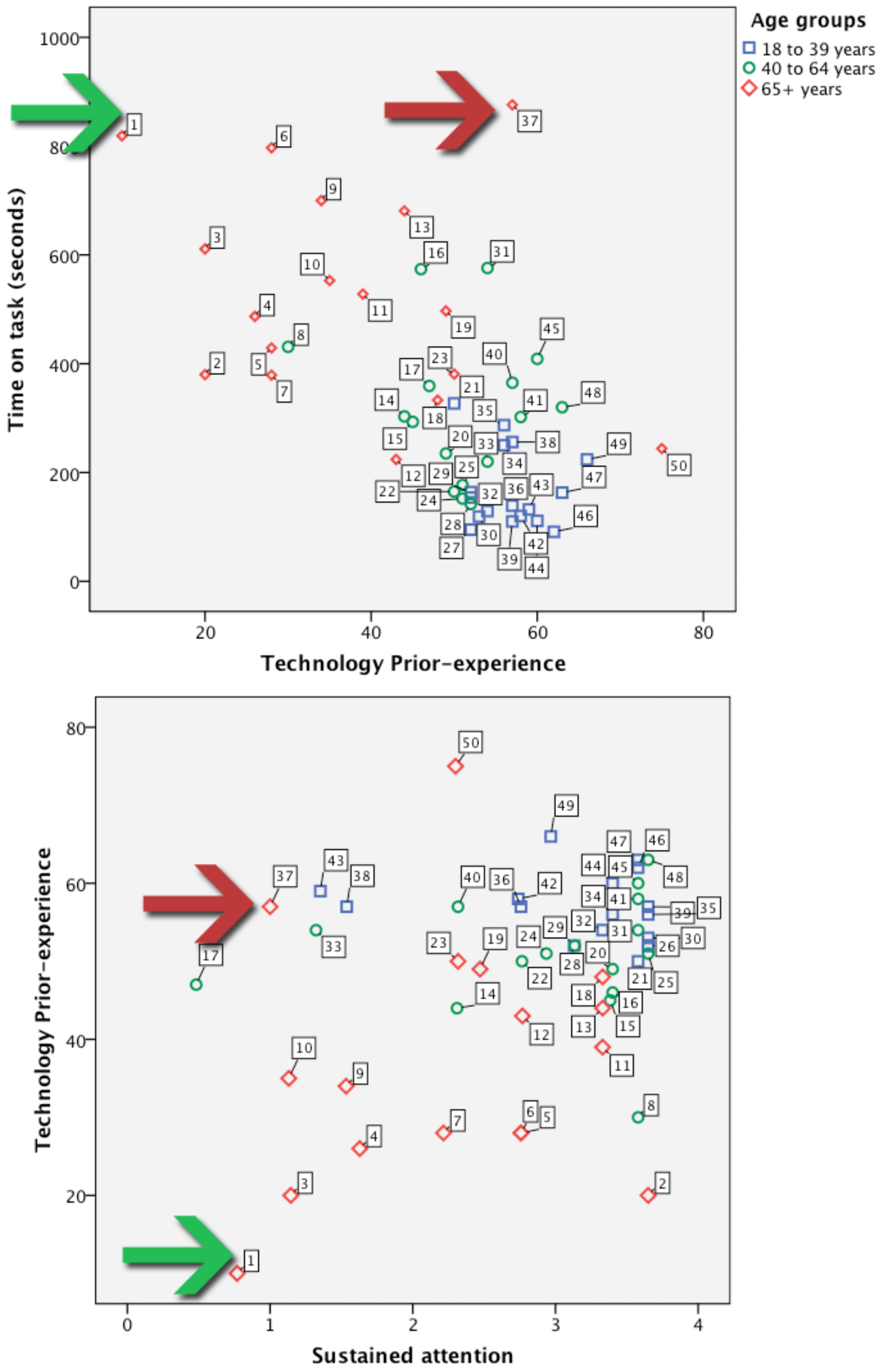

Figure 5: Scatter plots showing how sustained attention mediates the relationship between technology prior experience, age and time to complete the task

7. Discussion

The dictionary definition of "old age" is "the later part of normal life". What is normal life? 60+ years as old age is based on retirement age that was set when life expectancy was lower than currently. There is no conclusive evidence that shows that a person becomes old at 60 or 65 years. This not only perpetuates stereotype of "old" but also clouds objective research.

We realised during this study that if we look at our target group based on their capability (cognitive, sensorimotor) it is lot easier to address their problems. However, one of the problems with the proposed approach is that there is no standardised way to measure capability of a user. There are many validated instruments for measuring cognitive functioning of a person but their measurement scales are different. This makes it difficult to compare data from two independent studies that use different measurement instruments. Ideally, we want a set of easy to use universal instruments where we can get data that can be compared with similar studies elsewhere.

8. Conclusion

Diversity in older age groups often presents a challenge in developing intuitively usable interfaces. One of the ways we can address this problem is by shifting our focus from chronological age to cognitive capabilities of a user. We argue that chronological age is an arbitrary number that does not provide a stable ground for objective research. However, if we group our target users based on their capabilities it will provide us with a more effective approach in developing a solution.

In terms of capabilities, apart from sensory-motor functions, cognitive abilities provide a clear picture of a person's capability. Overall, our study strongly suggests that research on ageing and use of technology should focus less on the age variable and more on the source of age-related differences. Although chronological age is useful for understanding patterns of technology usage, preferences, and difficulty, it does not explain why these differences occur. To determine this; there is a need to investigate mediating variables such as cognitive abilities and domain-specific prior experience. In short, we should design based on capabilities of a target group rather than chronological "age".

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