Mobile Device Interaction Gestures for Older Users

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ABSTRACT
Finger gesture interaction on multitouch surfaces has become increasingly popular, especially on mobile devices. While manufacturers struggle to stake their claims in setting the next interaction standard, research still has to validate the 'intuitiveness' and 'naturalness' which is often attributed to this new interaction paradigm. Elderly users, who still struggle with interfaces that do not address their particular needs, abilities and knowledge, could especially benefit from a more intuitive and easy-to-use interface. This work addresses the question of which gestures might be appropriate for a range of common tasks on a generic mobile device for older users. Furthermore, we investigate whether the preferred gestures for a certain task differ between younger and older users. Results show that perceived suitability differs significantly on characteristics such as basic gesture type, fingers involved, or gesture complexity between the age groups.

Author Keywords
Gesture-based interaction, multi-touch interfaces, aging, user-centered design.

ACM Classification Keywords
H.5.2 [Information Interfaces and Presentation]: User Interfaces – *input devices and strategies, interaction styles*.

INTRODUCTION
The advent of the iPhone on the mass consumer market set the stage for touch and gesture-based interaction to leave the prototype niche it had been covering for years and become a commonly accepted novel way of interfacing technology. Since then, this input paradigm has spread to a huge variety of (mostly mobile) consumer electronic products, ranging from cell phones, PDAs, digital cameras, or navigation systems, to digital photo frames, music players, laptops and even desktop computers.

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Gesture-based input entails a couple of advantages for mobile interaction, such that it is "eyes-free, button-free, and silent" [4, p.11]. Furthermore, in the domain of mobile phones, using gestures as input patterns could render a cumbersome keypad-lock unnecessary [4]. However, with regard to Inclusive Design, there are also some potential drawbacks of gesture interaction, for example the loss of cues and affordances and a lack of haptic feedback compared to traditional button and menu interaction styles. The potential advantages and disadvantages of gesture-based interaction are discussed in [8].

If a gesture-controlled device should also be usable by an ageing user, or even facilitate the interaction, it needs to be carefully designed to account for the specific needs, abilities and knowledge of this user group (60+), so that the potential benefits of this technology outweigh the potential drawbacks. It is widely recognized and substantiated by numerous studies that elderly users have often particular problems when interacting with existing everyday technology [e.g. 1, 2]. The reasons why they struggle with technology are manifold, but can often be attributed to the physical, perceptual and cognitive changes that accompany the normal aging process. In many cases, the problems arise already at the interface level. Older users frequently report problems related to too small devices, buttons and text, an overload of functions, and too many (unnecessary) menus which are hard to understand and recall (e.g. in the context of mobile phone usage, [5]). Some of these problems could be reduced through appropriate touchscreen technology and suitable gesture design.

User generated gestures
Certain gesture patterns (c.f. [7]), for example the *pinch/spread to zoom out/in* have been popularized through commercially successful products such as the iPhone. However, these patterns are not standardized yet, and for other applications or devices no widely recognized gesture patterns have yet been established. To fill this open space and stake their claims for setting the next interaction standard, manufacturers as well as the scientific community suggest a large variety of different gesture sets and modes. A growing number of recent publications try not only to

propose new patterns as a proof-of-concept, but to ground the gestures in user-centered research: Hurtienne et al. deduced a gesture set from primary metaphor theory and validated it empirically with regard to Inclusive Design [3]. Wobbrock et al. proposed a user-defined gesture set for generic actions on a large scale interactive display [10]. In the context of finger gestures for mobile devices, Mauney and colleagues conducted a large scale study focusing on cultural differences in user-generated gestures [6]. In a similar study, we asked a younger and an older user group to perform suitable gestures for a range of typical actions on a mobile device [9]. The results showed that older adults differed significantly in the type of gestures they proposed. For example, they suggested more symbolic gestures (e.g. letters, numbers, arrows…), they relied less on multi-finger gestures and generally produced more complex patterns compared to the younger group. Partial correlations analysis showed that the strong associations between age and type of gesture persisted even if prior experience with cell phones or touchscreens and computer literacy was accounted for. Even if these results provided a first hint that suitable gestures might be different for younger and older users, the study can be criticized for involving too much ideation, which, considering the static prototype, was particularly hard for the less technology-savvy older user group.

Aim of the study

In order to investigate whether finger-gesture control has the potential of facilitating interaction for older users, we addressed the question of which gestures older users would deem appropriate for a range of common interaction tasks on mobile devices. In particular, with the study presented here, we tried to find answers to the following questions:

- Which gestures do older users perceive suitable for typical mobile interaction tasks?
- Do these gestures differ systematically from the gestures preferred by younger users?
- If so, what are the differentiators?

METHODS

We compared an older (60-75 years) to a younger user group (20-35 years) in a multiple-choice paradigm on 34 typical interaction tasks with regard to the perceived suitability of certain multitouch gestures for solving the tasks.

Participants

Altogether the study was conducted with 42 participants, among them 22 younger (M = 26.1 years, SD = 3.5) and 20 older (M = 67.0 years, SD = 3.9) participants. The younger group consisted of 10 female and 12 male participants; the older group was gender balanced. All but one of the older participants and 86 % of the younger participants were right handed. 85% of the older group were already retired, while 86% of the younger participants were students or employed.

1	select multiple (grid)	13	next page	25	rewind
2	select single	14	zoom in	26	next title
3	select multiple (list)	15	zoom out	27	previous title
4	move object	16	rotate	28	volume up
5	delete	17	pan	29	volume down
6	confirm	18	select text	30	take call
7	cancel	19	open menu	31	end call
8	open	20	help	32	make call
9	close	21	play	33	write message
10	scroll down	22	pause	34	send message
11	scroll up	23	stop		
12	previous page	24	fast forward		

Table 1. List of the 34 investigated interaction tasks.

Apparatus and Procedure

Participants were seated in front of two 17” TFT monitors (see Figure 1). On the upper monitor the 34 tasks were presented sequentially as a before/after screen. On the lower touchscreen monitor participants could playback short video clips for each task, showing four different solutions how to solve the task with a finger gesture. Each video showed a prototype device being held with the left hand with a printout of the before screen, on which the right hand performed a finger gesture. All video clips ended with a visual memory aid of the performed gesture by means of a superimposed red arrow retracing the movement pattern.

At the beginning of the experimental session, participants were shown the basic interaction capabilities of an iPod touch to get familiar with finger gesture interaction (without priming for any tasks that we tested). A demonstration task made them familiar with the paradigm, the touchscreen functionality and the solution space of possible finger gestures. For each of the 34 tasks that followed, participants were instructed to carefully watch the four suggested gesture solutions, and afterwards mark their perceived suitability on a 7-point Likert scale (1=not suitable at all, 7=extremely suitable). The procedure was self-paced and the participants could watch the videos multiple times, if desired. They were also handed a (switched off) iPod touch to imitate the gestures. The order of the tasks, as well as the spatial position of the different gesture videos on the screen was counter-balanced across participants.

Tasks and gestures

The set of interaction tasks we tested in this study contained 34 typical actions one might perform on a mobile device, ranging from generic (e.g. *select item*, *scroll up*) to more application specific (e.g. *pause*, or *send message*) tasks (see Table 1). The task selection and screen design was carried out as described in [9]. Of the initial 42 tasks tested in the previous study, eight were discarded as they had achieved

Figure 1. Experimental setup: Task descriptions are displayed on the upper monitor, gesture videos on the lower.

very low (< 0.1) agreement scores. The four gestures that were presented for each tasks had been selected according to the following criteria, based on the results of the previous study: the set must contain the two most frequently suggested gestures by the younger user group, the two most frequently suggested gestures from the older group, and the overall top three most frequently suggested gestures.

RESULTS

Across all ratings that the participants had to perform, the older group judged the proposed gestures on average as more suitable (M=4.45, SD=0.36) than the younger user group (M=3.99, SD=0.5), [t(40)=-3.307, p=.002].

Repeated measures analyses of variance (ANOVA) conducted for each task revealed that older users judged the presented gestures significantly differently from younger users in 50% of the tasks. In 20 out of the 34 tasks (59%), older and younger users differed in the gesture that was rated best. These results indicate that gestures which are perceived most suitable by one generation might not necessarily be the most suitable ones for the other generation.

Following up on the question of whether there exist some general characteristics of multitouch gestures which make them particularly agreeable for older users, a repeated measures ANOVA was carried out with *age* as between subject factor and *type of gesture* as within factor. The presented gestures had been previously classified in two basic types, being either *symbolic* (e.g. an arrow, an alphanumeric symbol, an icon etc.), or *direct manipulation* (e.g. a simple tap, press & hold, swipe etc., for more details see [9]). This analysis revealed, besides the main effect of age [F(1,40)=13.71, p=.001], a main effect of type [F(1,40)=84.54, p < .001], showing that direct manipulation gestures are in general rated more suitable than symbolic gestures. Most interestingly, we also found a significant interaction between *age* and *type* [F(1,40)=5.332, p=.026], indicating that direct manipulation and symbolic gestures were judged differentially in the two groups (Figure 2). While we found almost no age difference within the direct manipulation gestures [t(35,2)=-2.073, p=.046], there was a considerable age difference concerning the judgment of symbolic gestures [M_{young}=2.81, M_{old}=3.74, t(40)=-3.452, p=.001]. Similar analyses were conducted for further gesture characteristics, such as *number of fingers* (1-finger vs. 2-finger gestures), or *number of strokes* (simple unidirectional finger movements) that the gesture consisted of. There was no main effect for the *number of fingers*, but a significant interaction [F(1,40)=7.306, p=.01] between *age* and *number of fingers* (Figure 3). While young participants rated 2-finger gestures slightly higher than 1-finger gestures, the reversed could be observed for the older group. We also found a main effect of *strokes* [F(1.4,58.2)=58.56, p<.001], showing that the more parsimonious the gesture is, the more suitable it is generally perceived. Contrast analysis revealed that the gestures with three or more strokes differed significantly from the 1-stroke or 2-stroke gestures. Also here there was a significant interaction between *age* and gesture *strokes* [F(1.4, 58.2)=3.619, p=0.46], indicating that with increasing complexity of the gestures, younger users perceive the gestures increasingly less suitable than older users (Figure 4).

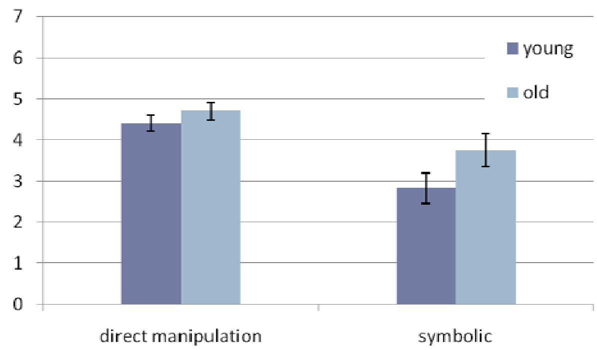

Figure 2. Perceived suitability of gesture type. (1=not suitable at all, 7=extremely suitable)

DISCUSSION

In order to find out how a mobile device interface based on finger-gestures should be designed to suit the particular needs of older users, we compared how older and younger users judged different gestures that had been established as promising candidates in a previous study [9]. Bearing in mind the limitations of our sample size, age range and experimental setup, we found that there are differences in the gestures that the two age groups prefer. While it is beyond the scope of this article to compare the best-rated gestures for each action and age group in detail, it is already worth noticing that these coincide in only 59% of all cases. These findings give credibility to the idea that gestures which are suitable for younger are not necessarily also the most suitable for older users and that devices might have to include different gesture profiles. To give but one example, while for zooming into a map (or picture), the younger user group rated the *2-finger spread* gesture – popularized by the iPhone - as best, the older participants preferred a discrete zooming through *double taps*, reflecting their general tendency to prefer single finger gestures. Looking closer at details of which general gesture characteristics are judged favorable by older users, we found that they are more likely to accept symbolic gestures than younger users, they are also less ready to perform multi-finger gestures, but, on the other hand, are more tolerant to gestures that are slightly more complex. These results support the findings reported in [9].

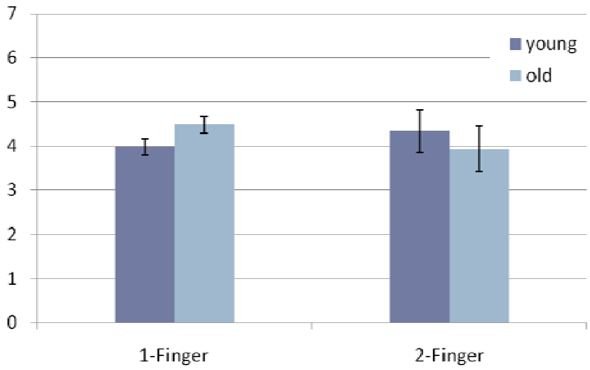

Figure 3. Perceived suitability of 1- and 2-finger gestures. (1=not suitable at all, 7= extremely suitable)

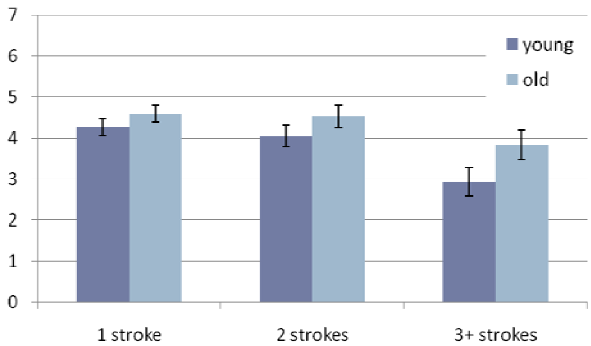

Figure 4. Perceived suitability of single-stroke, double-stroke and multiple stroke (3-6) gestures. (1=not suitable at all, 7= extremely suitable)

CONCLUSION AND OUTLOOK

The present study shows that gestures which are suitable for older users might be different from the ones that are designed with younger users in mind. If we want to exploit the potential benefits that gesture-based interaction could bring about, we need to carefully design interaction patterns suited to older people's needs and abilities. These results provide a first step towards framing gesture characteristics for this user group. However, further research is needed to deepen our understanding. The next step is to form a consistent gesture set from the best 'candidates' from this investigation, and implement these on a functional prototype. Only by testing them in real interactive scenarios will it be possible to measure their usability and determine whether this type of interaction can bring real facilitation in technology interaction to older adults.

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