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INTERNET APPLICATION FOR MOBILITY: NEW CHALLENGES DUE TO AN AGING WORLD

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The study examines the aging impact on the usability of internet platforms for mobility. Participants solved typical tasks on a platform for web-based travel information. Older adults' efficiency and effectiveness was contrasted to the navigation performance of a younger adult group. Learning the aging impact, participants' spatial ability, technical self-confidence and computer experience was assessed and related to performance. Older adults showed a distinctly lower navigation performance than younger adults. Beyond quantitative differences between age groups though older adults perceived the same interface problems than did the younger, showing that there is a general optimisation need. The aging disadvantage was mostly due to older adults' lower computer experience, which was the main player influencing performance in web-based searches.

Aging, internet, navigation performance, computer expertise, gender.

1 Introduction

The far-reaching demographic change with an increasingly aging population in combination with the diffusion of modern technical devices implicates that an incremental number of older people gets in contact with modern technology. At the same time request for mobility in every-day life is growing rapidly. On one hand, the replacement of printed information by information on websites may facilitate fast information seeking. On the other hand, these developments request the competent usage of technical devices and a broad accessibility for a diverse user group, as e.g. older users. Barriers like older users' decreasing cognitive abilities and lower computer experience come along with the fact that many websites still are not easy to use. It is a central research claim to examine how websites are understood by older persons and which problems they experience.

Recent studies show that cognition declines steeply after the age of about 40 (e.g. Fisk & Rogers, 2000; Salthouse, 1991). Also changes in sensory, physical and psychomotor functioning may be responsible for older adults' lower performance in using technical devices (e.g. Arning & Ziefle, 2007; Park, 1999; Ziefle & Bay, 2006.) Users' spatial ability shows to be a prominent factor for menu navigation performance (e.g. Downing et al., 2005; Craik & Salthouse, 1992). As spatial abilities decrease with increasing age (e.g. Downing et al., 2005; Craik & Salthouse, 1992; Ziefle & Bay, 2006), older users are more likely to experience disorientation and the feeling of "getting lost" than younger users while navigating through technical menus (Ziefle & Bay, 2004; 2006). Another player affecting the orientation in technical menus is verbal memory capacity (e.g. Arning & Ziefle, 2006; Bay & Ziefle, 2003; Ziefle & Bay, 2006). In addition, older adults often have a different technical understanding and are, due to a different upbringing, less experienced in computer usage, (e.g. Arning & Ziefle, 2007; in press;

Ziefle et al., 2007), what may also account for differences in computer-based performance (e.g. Czaja & Sharit, 1993; Rodger & Pendakhar, 2004). Noteworthy though older adults are able to perform as good as younger adults when they can rely on elaborated domain-specific knowledge (Downing et al., 2005; Morrow et al., 2004; Ziefle et al., 2007). Moreover technical self-confidence, the individual belief in one's own ability to solve technical problems, is also assumed to be an influential factor of navigation performance (e.g. Bay & Ziefle, 2003; Beier, 1999; Ziefle et al., 2006). In this context gender is an important factor to be regarded: Women often report lower levels of computer-related self-efficacy and higher computer anxiety (Bush, 1995; Rodger & Pendakhar, 2004). Low technical self-confidence reduces active computer interaction and may lead also to lower computer expertise levels (e.g. Arning & Ziefle, 2007; Rodger & Pendakhar, 2004).

2 Objectives

Older adults represent the fastest growing user group of the world wide web. Therefore we focused on the interaction of older users with Websites. In order to find out which specific characteristics affect websites navigation performance, users were surveyed regarding spatial and verbal memory abilities, their technical self-confidence and computer expertise. To reflect aging effects from another side, a control group of young adults was also examined. Beside age, the study concentrates on impacts of gender. Participants completed four prototypical Internet search tasks in the context of mobility.

3 Method

3.1 Variables

Independent variables were users' age (young vs. old) and gender. Dependent variables were the effectiveness and efficiency of menu navigation. For effectiveness, it was determined to which level tasks' objectives were achieved successfully. Users' navigation path while working on the task was compared to the "correct" respectively most direct navigation path for reaching the goal. Hence, the number of necessary menu steps was compared the number of steps actually executed. Measuring efficiency, time on task was related to an expert's time on task (benchmark). Both measures resulted in values from 0 to 1 with low values showing lower performance. Values of effectiveness constituting 1 mean that all four tasks were solved correctly. Data of efficiency averaging 1 implied that all tasks were solved as fast as an expert.

3.2 Participants

32 participants volunteered to take part in the study, 16 younger users (eight men, eight women), and 16 older users (eight men, eight women). The younger group had a mean age of 24.2 years (SD = 3.2), the older group of 57.3 years (SD = 8.6). Older users were recruited by a newspaper announcement, younger users by promotion at university. All participants had prior experience using the World Wide Web and, even the older group, had comparably high computer experience. Participation in the study was voluntary, and participants had a large interest in current technical applications.

3.2 Experimental Set-up

Object of investigation was an existing German local transport association website. Among other functions, the website contains information about different ticket types and prices, a scanning and a download function for timetables as well as tickets. A time

limit of 5 minutes was set for each of the tasks. Participants completed four prototypical tasks on the website. Task complexity was quite low: the menu depth was three levels at the most and all tasks could be solved with executing a maximum of 18 steps.
The following tasks were set up: (1) Finding the price for a bike ticket (Benchmark: 4 steps, 15 seconds); (2) Finding the departure time for a given route and arrival time (18 steps, 37 seconds); (3) Finding the route for a given departure time and address and a given arrival address (15 steps, 32 seconds); (4) Finding the description and the application for a special ticket offer (3 steps, 11 seconds).
In order to record participants' actions while solving the tasks online, a screen-capture program (Camtasia®) was used. After processing the tasks, participants completed the psychometric tests which are shortly described in the next section.

3.3 Psychometric Tests

To assess spatial ability, the paperfolding test (Ekstrom et al., 1976) was used. Each of the 20 items contained successive drawings of two or three folds made in a square sheet of paper and a hole punched in the folded paper. Participants had to select one of five drawings showing how the sheet would appear when opened. The maximum score was 20. In order to measure verbal memory (Bay & Ziefle, 2003)., participants 15 Turkish nouns which are unfamiliar to German native speakers were presented successively for 3 seconds. Directly after, participants had to recognize each target word among three phonologically or visually similar distractors. The maximum score was 15 points. The technical self-confidence (Beier, 1999) determines a person's subjective confidence regarding his/her competency when using technology. 8 items (e.g. "Usually, I cope with technical problems successfully")had to be rated on a five-point scale, ranging from 1 (totally disagree) to 5 (totally agree). The maximum score was 100 points. To measure the computer related knowledge, a computer expertise test containing 18 items was adopted (Arning & Ziefle, in press). All questions were dealing with theoretical and practical knowledge in the context of computer usage and software application and had to be answered by selecting one of four possible answers. The maximum score was 18.

4 Results

Results were analyzed by bivariate correlations, regression analyses, uni- and multivariate analyses of variance. The significance level was set to 5%, values within the 10% level were referred to as marginally significant. First outcomes in psychometric testing are reported. After that navigation performance outcomes are described. To get an overall impression of the navigation performance, performance of the four tasks was comprised. Second, the interplay of user variables and performance is focused upon.

4.1 Outcomes in psychometric testing

The results of psychometric tests are shown in Figures 1 a-c. Distributions of the single scores are illustrated rather than means to make age- related variations in all groups more transparent. Age differences appeared to be most pronounced in spatial abilities ($t(30) = 4.7$; $p < 0.01$, Figure 1a). Younger adults solved, on average, 12.9 ($SD = 4.5$) of 20 items, while older adults reached a mean score of 6.6 ($SD = 2.9$). Verbal memory also showed significant ($t(30) = 2.2$; $p < 0.05$) age differences (younger: $M = 12.3$; $SD = 1.7$; older: $M = 10.8$; $SD = 2.1$). Even the age difference in computer experience differed significantly ($t(25) = 2.4$; $p < 0.05$, Figure 1b). Younger adults reached, on average, 15.3 out of 18 scores ($SD = 1.4$), while older adults solved

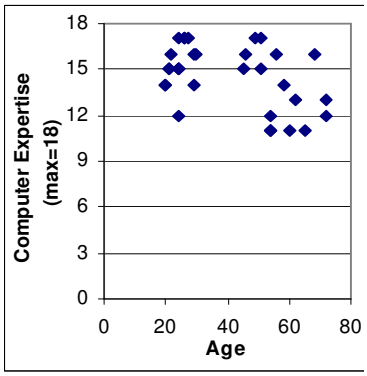

Figure 1a: Spatial ability

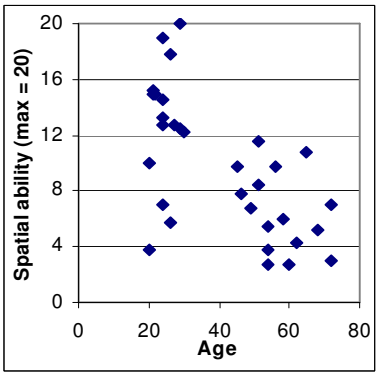

Figure1b: Computer Expertise

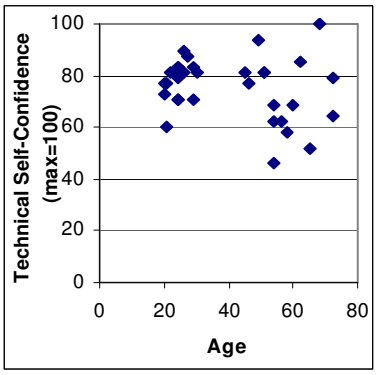

Figure 1c: Technical Self- Confidence

13.8 tasks (SD = 2.3). Though revealing a significant age effect, the older group demonstrated a very solid computer experience- not only when compared to more typical older adults (e.g. Arning & Ziefle, in press b; 2007), but also compared to the young adults' outcomes. Regarding the technical self-confidence (Figure 1c), no age differences were found. To understand interrelations between user characteristics, correlation analyses were run. Significant correlations between computer expertise and the technical self-confidence ($r = 0.65$; $p < 0.01$) were revealed. Also, spatial ability was positively related to computer expertise ($r = 0.41$; $p < 0.05$). Thus, high computer expertise came along with a high level of spatial ability as well as a high technical self-confidence. In contrast, verbal memory abilities did not show significant interrelations.

4.2. Effects of Age and Gender on Navigation Performance

In this section, the focus is on navigation performance and the question how the two age groups navigate on the website. A MANOVA was run with age group and gender as independent and effectiveness and efficiency as dependent variables. As taken from the omnibus F-tests, age had a significant effect ($F_{2,27} = 9.93$; $p < 0.01$). Younger users solved an average of 84% of the four tasks compared to 66% in the older group. Efficiency in the younger group was on average 0.27 compared to 0.16 in the older group. No significant main effect of gender ($F_{2,27} = 0.44$; $p > 0.05$) was present and also no significant effect of age and gender.

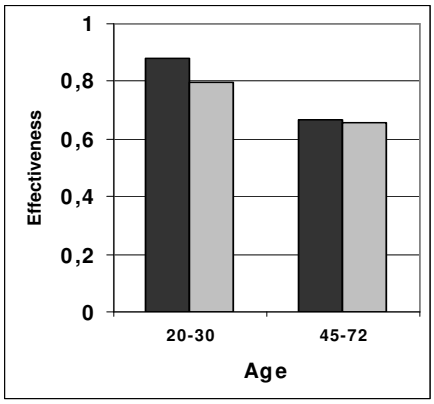

Figure 2a: Effectiveness

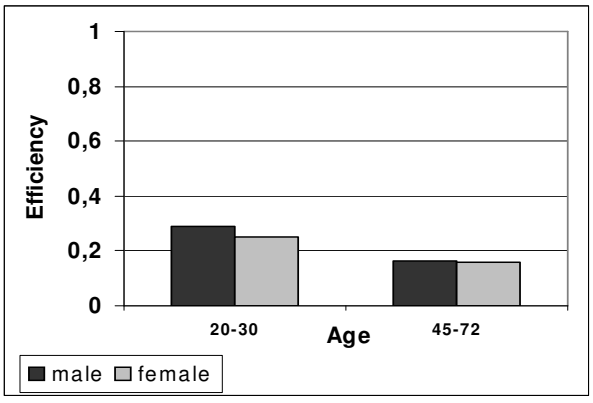

Figure2b: Efficiency

4.3 What mediates age effects

Analyse was done whether there were specific user characteristics, which affected navigation performance. The extent of computer-related knowledge showed to be strongly related to navigation performance (effectiveness: $r = 0.56$; $p < 0.01$, efficiency:

$r = 0.47$; $p < 0.01$). Also spatial abilities and effectiveness ($r = 0.48$; $p < 0.01$), verbal memory and efficiency ($r = 0.37$; $p < 0.05$) as well as self- confidence levels and efficiency ($r = 0.35$; $p < 0.05$) were related significantly.
To disentangle the specific relation and contribution of user characteristics to the aging effect and, in turn, the contribution of all variables to navigation performance, linear multiple-regression analyses were conducted. The relative impact of each of the users' characteristics on performance was determined in multiple- regression analyses in terms of explained variance (as predictors, age, spatial ability, verbal memory, self-confidence and computer on both, users' efficiency and effectiveness were included). Results show that age accounted for 37,5% of the variance of efficiency. All other measures were comparably dispensable for the navigation on websites, as they were disregarded by the regression procedures and no significant portion of variance could be explained by them. For effectiveness a different picture emerged. Computer expertise and age contributed to variance by 43% (computer expertise: $\beta = 0.036$, $p < 0.01$, age: $\beta = -0.005$, $p < 0.1$). Thus, having high computer expertise *and* belonging to the younger group enabled users to process the task successfully, while only belonging to the younger group enabled to solve the tasks fast.

5 Discussion and Conclusion

The present study demonstrates pronounced difficulties of both younger and older users in solving very easy and prototypical everyday applications for mobility on websites. Thus, it was shown unequivocally that the researched website was hard to handle even for younger and technology-prone adults. Thus, a imperative necessary adjustment of the website to users´ requirements was revealed. Contrary to previous findings, no gender effects on navigation performance were found. Gender effects are reported to appear due to women's higher computer anxiety and lower computer experience (Bush, 1995; Rodger and Pendakhar, 2004). The non-significant gender effect in this study may be due to the fact that women's computer expertise was equally high than that of male users. In this context, the mode of promoting participants needs to be considered. As participants announced themselves for the study, a highly selective sample was present, highly motivated, with a high computer literacy and a high technical self-confidence. Very probably, outcomes must thus be classified as euphemising the real situation. In spite of the highly selective sample, older adults had a significantly lower performance than younger adults. The problems experienced by this older group are likely to be exacerbated for older adults with less technology experience or those, who have some type of (age-related) impairment. Thus, in future studies, more typical older users should be considered. Nevertheless, one of the key findings is that computer experience is in fact a major player for success: Older adults with high computer expertise were able to nearly reach younger adults' navigation performance, confirming findings of Downing, et al. (2005) and Morrow (2004). No other cognitive variable showed this strong influence on users' output.
Summarizing, given a high level of computer expertise, gender effects in performance vanish and age effects can be reduced to a minimum. However it is innocent to believe that computer expertise just "grows out of nothing". Rather, computer experience develops from a continuous and active computer work. This underlines the importance of reducing barriers of computer usage in general and website usage in particular, as frequent usage goes hand in hand with increasing computer literacy. But it was found

also, that current websites show high requirement and potential of bettering as even the high experienced users had problems in solving four everyday tasks.

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