The Fragmentation of Attention in Mobile Interaction, and What to Do with It

Antti Oulasvirta > Helsinki Institute for Information Technology > antti.oulasvirta@hiit.fi

SIX YEARS AGO, Kristoffersen and Ljungberg [3] reported that mobile people need to "make place" for using their mobile devices; for instance, a pedestrian might need to stop walking to write a text message—a situation we're all familiar with nowadays. In a line of research on mobile cognition, our goal has been first to understand how serious this "multitasking craziness" [2], or fragmentation of attention as we see it [4], is, and also to explore some possibilities to counter this unwanted phenomenon.

The unbearable cost of mobility. To make a long story short, we conducted a field experiment (see Figure 1) to investigate the seriousness and extent of fragmentation. The data conveyed the impulsive and drastically short-term nature of attention "in the wild." Two measures represented in Figure 2 are particularly illuminating: the span of attention and the frequency of shifting. In mobile situations, continuous attention to the mobile device fragmented to bursts of just four to eight seconds from the 16 seconds of the laboratory, and attention to the mobile device had to be interrupted several attention shifts, by glancing the environment up to eight times during a page loading (in comparison to under one in the laboratory condition)! (Moreover, the real differences are most likely even more whopping since results from our laboratory condition probably exhibited a ceiling effect.)

Others' recent findings also suggest that attention in the office is much, much less fragmented, the span being approximately three minutes [2], depending on the way it is operationalized. Clearly, going mobile really takes multitasking to an extreme where interaction and attention break down to bursts of just a few seconds.

Interestingly, we observed several strategies that users adopted to compensate for this unwanted situation. In general, the simple strategies can be described as strategic withdrawals of resources from less important tasks (e.g., slowing down walking, or postponing and refusing tasks). More sophisticated strategies were enabled by users' preknowledge of the particular situation. For example, when a metro leaves from the station, travelers "preprogram" themselves to what is to be expected; in this case to the announcement of the destination station. After this calibration, only brief sampling is required to observe that the task is proceeding normally.

...And what to do with it? Some design tactics to fight mobile multitasking craziness. Given all this, it is interesting to note that some mobile applications presume use scenarios in taxing situations but provide only weak interaction support for them by requiring almost all cognitive and motor resources. Think about, for example, location-based tourist guides, some of which require two hands and visual gaze in an intense, fast-paced interactive loop to operate.

Based on the lessons learned also in three similar studies, some insights on how to fight the fragmentation have begun to surface.

At the very least, our results should convince designers to put effort to:

- shorten interaction units (down to less than five seconds). Chunking tex-

tual material and dividing episodic materials into smaller episodes might help. The briefer the attentional capture, the smaller the temporal overlap with other tasks.

Practitioners doing work with mobile devices have noticed the same. For example, Tim Brown of IDEO mentioned in his CHI 2004 closing plenary that one goal for his team in designing pleasurable interactions for mobile devices is that completing a task should not take longer than 20 seconds [1].

Needless to say, but the exact target span of course depends on the use situations of the particular application. In general, those mobile situations with many tasks tapping visual and motor resources, or with particularly intensive ones, should lead to more fragmentation. And, as shown, in the worst case the span can be down to five seconds. Estimating an appropriate target span requires knowing and analyzing the use contexts, something that of course is an old message to HCI practitioners. However, in our task analyses of mobile situations, we quickly realized how surprisingly complex simple-looking situations might be. For example, waiting for a metro to arrive is not simply about sitting idly with all resources available, but actually demands a lot: estimating when the metro arrives, moving to a position where it can be perceived, continuously interpreting auditory sense data, monitoring and reacting to intrusions of personal space by by passers, periodically glancing to see if the metro is coming, etc.

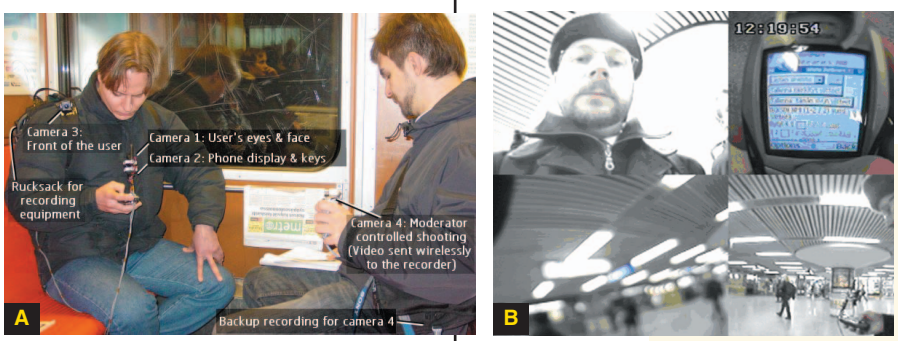

Figure 1. A) The minicamera setup used to record attention, action, and context. B) Video integrated on the fly from the four streams.

STUDYING ATTENTION IN THE WILD

In the experiment, 28 participants performed assigned information-retrieval tasks using Opera browser running on a Nokia 6600 smart phone. They were taken to eight urban situations (see Figure 2) and either asked to do something typical of that context (e.g., walking a street or drinking coffee in a cafeteria), or the tasks were implicit in the situation (e.g., not violating others' personal space or getting off the escalator).

The goals in constructing the recording equipment were light weight and unobtrusiveness. Four 30 g Watec WAT 230A minicams were used for recording. Video streams were sent wirelessly to a receiver in the participant's backpack and backed up onto a tape carried by the experimenter.

We manually coded from the video the deployment of visual gaze, mode of movement, external events, and interaction with the device.

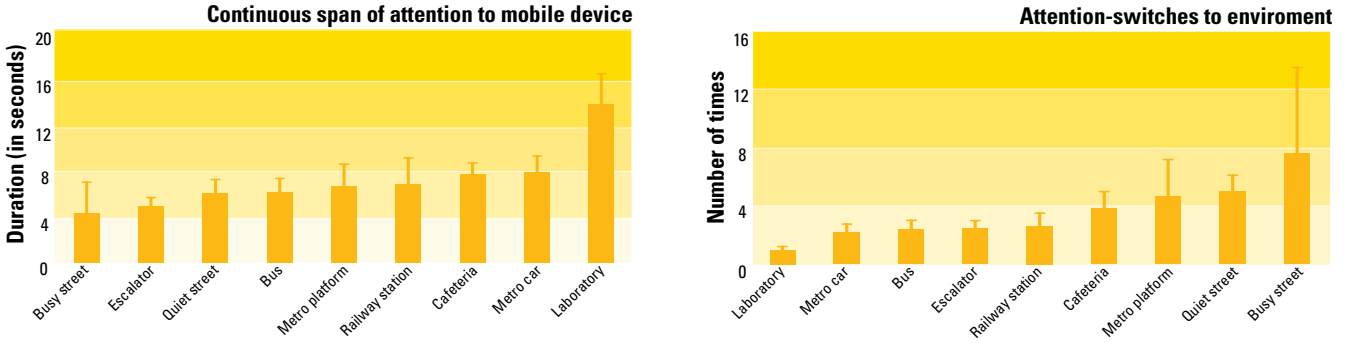

Figure 2. A) Duration of continuous span of attention and B) number of attention switches to mobile device in nine different reference situations.

Careful task analysis can also help to:

- automatize or eliminate tasks. Fewer tasks naturally mean less cognitive competition.

In addition to these quite trivial tactics, or at least ones predictable to people educated in HCI, efficient use of available cognitive and motor resources should be supported:

- Offload tasks to unused resources, support execution of tasks in different modalities. Providing possibilities to execute tasks in different modalities might in some situations reduce resource competition.

...as well as their user-driven monitoring:

- Provide modality-targeted feedback for long system response times. For example, in turntaking-based interactions such as page loading in Web browsing, providing tactile feedback makes it possible to release visual resources from monitoring the page loading [5].
- Support brief monitoring of changes. In dynamically updating applications, special care should be put to support quick user-driven monitoring by providing concise yet powerful representations of changes.

...and control:

- Support temporal control and orchestration. In particular, it is important to support rapid switching, postponing, delaying, restarting, interrupting, finalizing, and planned sequencing of tasks.
- Provide unsanctioned delaying of responses. An important corollary of the previous one is that delaying of responses, which is unavoidable in taxing mobile situations, should not lead to undoable consequences.

Finally, the kind of preknowledge-driven attentional strategies discussed above might be another fruitful avenue for designers:

- Provide cues for anticipation of upcoming events and schedules. For example, progress bars in page loadings and task diagrams in wizard applications fall into this category.
- Support user's understanding of tasks' upcoming demands. This requires creating learnable and consistent patterns of interaction—ideally users can use their mental representations (models?) to anticipate events and thus release cognitive resources from constant monitoring of events on the mobile device.

ACKNOWLEDGEMENTS *The work reported here has been done in collaboration between Helsinki Institute for Information Technology, Helsinki University of Technology, and Nokia Research Center. I am indebted to several people, including Jaakko Aspara, Tuulia Haikarainen, Tero Jantunen, Jaana Kuorelahti, Harri Lehmuskallio, Miikka Miettinen, Tuomo Nyyssönen, Virpi Roto, Heikki Summala, and Sakari Tamminen. The Nokia Multimedia Business Group and the Academy of Finland have provided financial support for the work.*

ABOUT THE AUTHOR

Antti Oulasvirta is currently researching context awareness at the Helsinki Institute for Information Technology and completing his doctoral dissertation on how interruptions and multitasking are cognitively managed in HCI settings. He worked as a Web usability specialist for several years and acquired training in cognitive psychology at the University of California, Berkeley.

REFERENCES **1.** Brown, T. (2004). The future of designing experiences. Closing Plenary at CHI 2004, Austria Vienna, 29 April 2004. **2.** González, V.M. and Mark, G. "Constant, constant, multi-tasking craziness": managing multiple working spheres. In *Proc. CHI'04*, ACM Press (2004), 113-120 **3.** Kristoffersen, S. and Ljunberg, F. (1999). Making place to make it work: Empirical exploration of HCI for mobile CSCW. In *Proc. GROUP'99*, ACM Press, New York. **4.** Oulasvirta, A., Tamminen, S., Roto, V., and Kuorelahti, J. (2005). Interaction in 4-second bursts: The fragmented nature of attentional resources in mobile HCI. In *Proceedings of SIGCHI Conference on Human Factors in Computing Systems (CHI 2005)*, ACM Press, New York, pp. 919-928. **5.** Roto, V., and Oulasvirta, A. (2005). Need for non-visual feedback with long response times in mobile HCI. A full paper to appear in *Proc. WWW2005*, Japan, Chiba, May 2005.