Modeling Individual Strategic Behavior in Human Multitasking

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Individual differences and multitasking

Computational modeling is a tool often used in cognitive psychology to simulate a particular behavior using a computer. Most cognitive models strive to explain users` overall performance without distinguishing between single individuals. However, there is ample evidence for individual differences in performance. Consequently, my perspective is hybrid: individual differences on the one side follow from (cognitive) abilities (Ackerman, 2005), on the other side the applied user strategies adaptively determine different task performance among people (Schunn & Reder, 2001). Scope of my research is to investigate individual cognitive strategies in dynamic multitasking environments and to focus on resulting theoretical consequences for modeling.

Empirical investigation

In two successive experiments in a car driving simulator, students of the TU Berlin were ask to perform a modified version of the D2 test of attention by Brickenkamp (2001), hence D2-Drive. The scenario constitutes a model of compound continuous tasks (Salvucci, 2005) due to the requirements defined by the tasks themselves. We used three versions of the secondary task (D2-Drive) to exert increasing complexity.

Performance increase during multitasking

Unlike our starting assumptions, participants` relative performance while multitasking in both studies increased. Three main reasons account for our surprising findings, namely (1) learning by experience, (2) emerging and use of cognitive strategies and (3) forming of a new (multitasking) skill. Following Taatgen (2005), skill acquisition involves progressing from slow, deliberate processing to fast, automated processing. This was confirmed by both faster reaction times and error-free performance.

Cognitive models to account for differences

First step towards the modeling of multitasking turns out to be the simulation of the secondary task. We started with a baseline model (Dzaack, Kiefer, & Urbas, 2005) that reflects participants` performance in the D2-Drive test at the beginning of the experiment. However, this model does not incorporate improvement in performance based on learning by training. Participants` verbal reports as well as eye movement data suggest that, under multitasking, cognitive strategies are used to optimally adapt to the situation. A second model contains a strategy we call “blocking”, illustrating that participants seem to understand the degrees of freedom they have and, for instance, parallelize motor action (pressing a button) and visual scans (gaze at lane). This goes in line with common assumptions on constraint-based modeling such as the claim in the information-requirements grammar approach (Howes et al., 2005). However, cognitive strategies do not necessarily occur with all participants, in fact they seem to depend on multiple factors (e.g., memory capacity or cognitive style).

Conclusion and Outlook

Cognitive strategies were found in two experiments and successfully transferred into ACT-R 6. The usage of these strategies apparently explains individual differences in dynamic task environments. The next step is twofold: indicators are needed to predict time and frequency of strategy application before both tasks are implemented in a cognitive model of human multitasking in dynamic systems.

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