Boundaries of Modeling Human Multitasking

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Understanding Human Multitasking

Aim of the empirical studies on human multitasking referred to in this contribution was to illustrate how people manage the concurrency of several tasks in a dynamic task environment, as also investigated by Salvucci (2005) or Taatgen (2005). With other words, purpose of our applied multitasking scenario in four studies including training aspects (study one), task variation (study two), time pressure (study three) and systematic task interruption (study four) was to incorporate the following aspects:

- *Ecological validity:* The conducted studies were meant to simulate a real-life scenario. Most traditional research on human multitasking or dual task performance (for instance, see Pashler, 2000) does not reflect properly what happens outside of the lab.
- *Task repetition*: Lee & Taatgen (2002) tried to see human multitasking in the context of skill acquisition. Skill acquisition requires task repetition and training.
- *Methodological stability*: Strayer & Johnston (2001), Salvucci (2005), and various others used typical tasks like dialing a number on a cell phone. Though being quite realistic, the systematic control of a highly ecological valid task remains unclear. For this reason, in our studies, we used a test of attention (for more details, see Kiefer, Soyak, N., Lischke, R., Höger, R., and Thüring, M., 2008).

Figure 1: Multitasking scenario in the lab:
driving task (left) and concurrent attention task (right).

- *Situational influences:* Multiple tasks occur in a situational context, not isolated from a context and factors like time pressure or mental fatigue. These aspects play a key role and – if possible - should be included when modeling human multitasking.

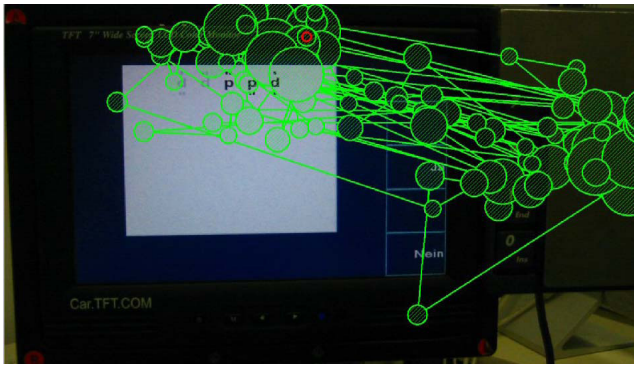
Cognitive Modeling and Multitasking

"Defining symbol structures for specific cognitive tasks" (Werner H. Tack, personal communication) helps understanding the cognitive processing and provides a method to systemmatically compare pre-empirical assumptions (put into a model) with behavior in real life, as simulated in an experimental multitasking scenario. The optimal cognitiv architecture for our approach was ACT-R. Reasons for our choice were:

1. ACT-R includes plausible assumptions on human memory (see Taatgen, 2005) and the applied tasks can easily be simulated using the ACT-R framework.
2. ACT-R is able to interact with the environment and turns out to be the best candidate for dynamic tasks. Many ACT-R models on dynamic tasks do already exist, for an overview, please see Salvucci (2005).
3. ACT-R provides a framework for task switching and task interruption (as illustrated in the work by Brumby, Salvucci & Howes, 2007). Brumby et al. (2007) apply IRG (Information Requirement Grammar, see Howes, Lewis, Vera & Richardson, 2005, for a closer look).

Modeling Human Multitasking

Kushleyeva, Salvucci & Lee (2005) focus on the question when to switch between tasks and mention three criteria which need to be met for what they refer to as “satisfactory multitasking performance”. These criteria are (1) the ability to create and schedule future intentions, (2) the facility to remember and prioritize these intentions, and (3) the ability to switch from carrying out one to another task. Future intentions, e.g. when interrupted by a secondary task and later forced to resume the interrupted primary task, refer directly to prospective memory (which was analysed in Kiefer et al., 2008). Also, please see Altman & Trafton (2002) for providing a convincing model on memory for goals, which in our eyes is a promising candidate for modeling of prospective memory in the context of human multitasking.



Boundaries on Modeling Multitasking

Eye tracking data, performance in both single tasks individually as well as under multitasking conditions, verbal reports as well as physiological data confirm us in assuming that, unlike proposed by IRG or other approaches, task switching is not directly a function of free, available resources or information, but rather depends on

- the configuration of all involved tasks and their interaction within the empirical context.
- time pressure: mainly experienced time pressure, but also externally driven time pressure by instruction and acoustic warning signals.
- a lack of sufficient training, which can be easily applied before the multitasking scenario itself takes place.

The proposed general multitasking component by Salvucci (2005) is a promising approach to successfully model human multitasking. However, we further recommend to

(a) provide a stronger systematic control of the involved tasks (as well as task repetition in terms of training)
(b) include aspects like mental fatigue and time pressure within the entire model
(c) understand the entire performance in the multitasking scenario as one overall task which is not necessarily directly connected to free, available resources.

The Future of Modeling Multitasking

Lots of research has been done quite recently on human multitasking. Promising ACT-R models do exist to approach the challenge to model the handling of several tasks at the same time. We are currently using the insights of our empirical studies to enrich an already existing ACT-R model by understanding that humans do not seem to follow rules of optimization. One step towards this direction is the identification and modelling of multitasking heuristics.

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