

Time Monitoring and Cognitive Control in Children and Adults

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Background and Research Objectives

Most goal-directed activities require temporal integration and monitoring of action sequences (Atkin & Cohen, 1996; Fuster, 2002). For example, memory for future intentions involves a monitoring phase during which the individual has to pay attention to the target event among other events (e.g., “turn left after the third intersection”). However, most everyday activities involve multiple goal-directed tasks and optimal monitoring requires a *strategy* for scheduling actions (i.e., when and how to monitor).

In this study, we examined time monitoring strategies in school-aged children (8-12 years), younger adults (20-35 years), and elderly adults (65-80 years). Our primary aim was to examine time monitoring in relation to individual differences in executive control functions. Most future-oriented tasks, including prospective memory, are assumed to depend on the prefrontal system and the integrity of the executive systems that these systems subserve. Furthermore, patient studies indicate that dysfunctions in executive functions are associated with problems in temporal orientation.

We hypothesized that strategic time monitoring (as measured by number of clock checks and timing errors) would be systematically related to individual and developmental differences in executive functioning. Specifically, children and older adults were expected to show less efficient monitoring strategies than younger adults and older children. Furthermore, individuals with less efficient executive functions were expected to rely more on inefficient monitoring strategies than individuals with better functioning control processes.

We assessed executive functions by using a multivariate approach. Specifically, we focused on three basic constructs of cognitive control, namely, mental set shifting, updating, and inhibition of prepotent responses, respectively. Each construct was measured by multiple experimental tasks that were assumed to tap a specific target function.

Time monitoring was based on a computerized task in which participants indicated the passing of time every 5 min, while carrying background activities that varied in concurrent task demands (e.g., watching a movie or completing as a series of cognitive tasks). Furthermore, each participant’s time judgment was examined in a separate *time reproduction task*.

Main Findings

Results indicate developmental differences in time monitoring, so that younger children and older adults monitored more frequently and made greater errors than older children and younger adults. Inconsistent with the findings of Ceci and Bronfenbrenner (1985; see also Harris & Wilkins, 1982), also the youngest (8-year-old) children showed linearly increasing monitoring functions with few clock checks during the initial phase of a monitoring interval. Furthermore, this pattern of monitoring was observed for each of the 5-min interval, (i.e., a sawtooth function).

In contrast to the time monitoring data, there were no systematic age effects in duration judgment, as measured by the time reproduction task. Specifically, both children and adults overestimated stimulus durations, and these effects were greater for longer durations than for shorter durations.

Finally, individual differences in executive functions were related to time monitoring, so that individuals with problems in the inhibition and updating components of executive functioning showed inefficient monitoring strategies.

Taken together, these findings suggest a close link between aspects of executive functioning and time monitoring. We will discuss our findings in relation to a more general perspective on time monitoring, including related work in the context of operant conditioning, process control, and artificial intelligence.

References

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