

Developmental Changes in Cognitive Control. Temporal Dynamics of Task Performance across Trial Sequences.

S.F.A. Smulders

SUMMARY

The current thesis aimed at expanding our knowledge of age-related changes in trial-by-trial effects on the speed of performance. More specifically, this thesis was concerned with the study of developmental change in sequential effects (Chapters 2 and 3), post-error slowing (Chapter 4) and conflict adaptation (Chapter 5). These issues were addressed by using varieties of standard choice reaction tasks to enable appropriate comparisons with the adult literature. In addition, the results that emerged from these studies were interpreted vis-a-vis a common framework of cognitive control that has been adopted in the developmental literature; i.e., the dual-mechanisms of control model (DMC). The model distinguishes two modes of control; i.e., reactive vs. proactive control.

Chapter 1 offered a general introduction addressing the key topics covered in this thesis. The concept of cognitive control and the developmental changes therein was explained, and the three main topics (including the questions addressed in this thesis) that were central to the four empirical chapters (2-5) were introduced.

Chapter 2 and 3 together contained four experiments that aimed to investigate systematically the developmental trends in basic processing mechanisms underlying sequential effects in serial reaction time tasks (i.e., automatic facilitation and subjective expectancy). The experiments in Chapter 2 were aimed at assessing developmental trends in the strength of these mechanisms, by manipulating response-to-stimulus (RSI) interval and stimulus-response compatibility (SRC). The primary goal of the experiments presented in Chapter 3 was to assess how developmental change in these underlying mechanisms evolve, by manipulating RSI in small steps and introducing practice-sessions. The results presented in Chapters 2 and 3 contributed to the relatively scant developmental literature on sequential effects. This literature was primarily concerned with first-order sequential effects and indicated that young children's performance is dominated by a repetition benefit (i.e., automatic facilitation). This observation was replicated. We also included analyses of higher-order effects. These analyses revealed a benefit-only pattern (i.e., automatic facilitation) that was stronger when incompatible reactions were required relative to compatible responses. Consistent with expectations, the strength of the benefit-only pattern decreased with advancing age but, inconsistent with expectations based on previous findings, this pattern was not influenced by extensive practice. Interestingly, the benefit-only pattern continued to dominate the performance pattern in young children across RSIs of varying lengths whereas, consistent with previous findings, the adult benefit-only pattern changed into a cost-benefit pattern (i.e., subjective expectancy) with a lengthening of RSI.

We considered but rejected the idea of interpreting our findings in terms of the DMC-model. We resorted to simulation studies of sequential effects in order to obtain an appropriate account of our developmental findings. Our review of this literature converged on the conclusion that most interpretations are concerned with sequential-effects patterns associated with long RSIs whereas the patterns associated with young children are typical for short RSIs. Finally, we assumed that sequential-effect patterns associated with short RSIs and young children are to result from passive expectancy that is automatic and effortless while the sequential-effects patterns associated with long RSIs and older participants are supposed to be due to active expectancy that is consciousness and effortful. We had to admit that this interpretation is utterly abstract and in need of further investigation.

Chapter 4 was concerned with the examination of developmental change in post-error slowing. First, we reviewed the developmental literature for information on post-error slowing and observed that the scant literature yielded inconsistent findings. This prompted us to systematically assess age-related change in post-error slowing using a standard choice reaction task. Our analysis revealed a robust developmental pattern of post-error slowing; i.e., the magnitude of slowing decreases with advancing age. This finding indicated that young children do monitor their performance and respond accordingly when they committed an error.

Post-error slowing has been interpreted in terms of a dynamic interplay between proactive and reactive control. On the hypothesis that proactive control is immature in young children their pronounced post-error may relate to less proactive support of the implementation of remedial action. Although this interpretation could not be excluded based on the current findings, we believed that the current interpretation of post-error slowing in terms of response caution is more straightforward. There is strong evidence to suggest that post-error slowing is associated with an increase in response caution. Accordingly, the disproportional slowing observed for young children was explained by assuming that young children experience difficulty in fine-tuning their response thresholds. Obviously, this interpretation should be evaluated in future studies.

Chapter 5 presented a study that systematically assessed developmental change in conflict adaptation. The developmental literature showed an inconsistent pattern of results. We used different conflict tasks (a Simon task, an SRC task, and a Choice-reaction/ NoGo task) as the specific implementation of conflict adaptation may depend on the specific conflict elicited by the task and, thus, may contribute to the inconsistencies observed in the developmental literature. The findings demonstrated conflict adapta-

tion in each of the age groups participating in the study and for each of the tasks that were used, although specific patterns differed across tasks.

The predominant idea in the developmental literature is that conflict adaptation is a manifestation of top-down control that has a protracted developmental course. Accordingly, one would assume that young children do not exhibit conflict adaptation. But the current findings convincingly indicated that they do. Consequently, these findings presented a challenge to the idea that conflict adaptation is realized via top-down cognitive control or, within the framework of the DMC, in terms of a flexible balancing of proactive and reactive control mechanisms. We argued that our findings can be accounted for in terms of episodic retrieval. Within this context, conflict adaptation was assumed to result from memory-driven effects. Although this account does not exclude a potential role of proactive control, its contribution was not or minimally manifested in the current data.

Chapter 6 provided a general discussion based on the results of the empirical chapters. An attempt was made to integrate results across studies and to derive some conclusions regarding the developmental changes in reactive and proactive control processes.

Taken together, the thesis presented trial-by-trial approaches in examining age-related change on the speed of performance. In all the approaches investigated, we rejected the idea of interpreting the results in terms of reactive and proactive control and resorted to other accounts of our developmental findings. The results of the experiments in this thesis assume that the developmental changes in the temporal dynamics of task performance across trial sequences can be interpreted without using top-down control adjustments between trials.