Automatization and deautomatization of perceptual-motor skills

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Summary

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The process of skill automatization allows us to perform complex tasks such as sports, crafts, riding a bike, or driving a car. This thesis explored the role of cognition in motor automatization, but also in the practically relevant, but theoretically largely overlooked process of deautomatization. As an introduction into these topics, Chapter 1 provides an overview of earlier work on movement automatization as well as an exploration into when and how movement deautomatization might play a role in performance.

The first experiment, presented in Chapter 2, examined the respective roles of explicit rules about movement execution (analogy vs. explicit learning) and focus of attention (movement focus, environment focus) in learning and automatization of the table tennis forehand and how learning under these different conditions influences subsequent performance under pressure. Results revealed that the accumulation of a large number of explicit rules about task execution, rather that the direction of attention during learning, was detrimental to performance under pressure and secondary task loading. This result is in concordance with earlier work showing that minimizing the accumulation of explicit rules about task execution during learning prevents performance disruption under increased pressure.

However, thus far, previous research examining the effects of analogy and explicit learning on performance automatization and deautomatization did not employ many more than 500 repetitions. Therefore, in Chapter 3 we sought to test the effects of analogy and explicit learning on performance under pressure at higher levels of automaticity up to a total of 10,000 repetitions. Importantly, despite differences in rule formation, neither group appeared to show performance decrements under pressure or secondary task loading after 1,400 or 10,000 repetitions. This finding is not in line with the reinvestment hypothesis, as despite a relatively high number of explicit rules, performance of explicit learners did not decrease with increased anxiety. All in all, the combined results of Chapters 2 and 3 are more supportive of an attention control account rather than a conscious processing or reinvestment account of choking.

In Chapter 4 we took a different approach to performance automatization and deautomatization by manipulating, amongst others, movement preparation time in a table tennis task similar to the one employed in Chapters 2 and 3. In the two experiments reported in Chapter 4 we looked into the effects of expertise (Experiment 1) and instruction (explicit instructions vs. an analogy instruction; Experiment 2) on performance in environments that encourage attention towards movement preparation and execution (i.e., skill-focus instruction or lengthy movement preparation periods) in contrast to environments that minimize the opportunity to attend to movement preparation and execution (i.e., dual-task conditions or high temporal constraints). The results of Experiment 1 show that skill-focus conditions and slowed ball frequency disrupted the accuracy of experts, but dual-task conditions and speeded ball frequency did not. For novices, the effects were reversed. In the second experiment, we extended these findings by instructing novices either explicitly or by analogy. Explicitly instructed novices were less accurate in dual-task conditions than in single-task conditions. Following analogy instruction novices maintained accuracy under dual-task conditions, replicating the findings in Chapters 2 and 3. Also, participants in both conditions retained accuracy when ball frequency was slowed, but lost accuracy when ball frequency was speeded. These results suggest that not attention, but motor dexterity, was inadequate for novice performance under high temporal constraints.

In Chapter 5 we studied movement automatization from a third angle by conducting three experiments aimed at gaining insight into the processes involved in the learning of two similar movement sequences with a specific interest in how automaticity of sequential performance influences interference effects between similar movement sequences. These experiments employed a button-press task as experimental task. Experiment 1 established the nature of the interference effects, providing evidence for button-specific pro- and retroactive interference effects. Experiments 2 and 3 further probed the mechanisms underlying those effects, by varying the numbers of repetitions (50 or 250) of the first and second sequence (Experiment 2) and the hand, dominant or non-dominant, with which the sequences were practiced (Experiment 3). The results of Experiments 2 and 3 suggest that changes in the representation of the movement structure are primarily responsible for the observed interference effects.

Finally, in the general discussion the results of the performed experiments are discussed and evaluated within relevant frameworks. One conclusion consistently emerging from the reported experiments is that skill automatization seems to establish already very early in learning. This is in contrast with well-established theories that posit automaticity to be the final step in reaching expertise rather than a relatively early step.