Task-set control and procedural working memory

Submitted by Félice Maria van ‘t Wout to the University of Exeter

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I certify that all material in this thesis which is not my own work has been identified and that no material has previously been submitted and approved for the award of a degree by this or any other University.

Signature:……

Abstract

Flexible and goal-driven behaviour requires a process by which the appropriate task-set is selected and maintained in a privileged state of activation. This process can be conceptualised as loading a task-set into a *procedural working memory (PWM)* buffer. Task switching experiments, which exercise this process, reveal "switch costs": increased reaction times and error rates when the task changes, compared to when it repeats. The process of loading a task-set into PWM may be one source of these costs. The switch cost is reduced with preparation, suggesting that at least some of the processes involved in a successful change of task can be achieved in advance of the stimulus.

The aim of this thesis was to investigate the properties of PWM, and its contribution to task-set control. One account of PWM distinguishes between the level at which recently exercised (but currently irrelevant) task-sets are represented, and the level at which only the currently relevant task-set is maintained in a most active state. To distinguish between these levels of representation, and to assess the extent to which the process of getting a task-set into a most-active state (loading it into the PWM buffer) is subject to a capacity limit at each level, the experiments varied the number of tasks participants switched among (Experiments 1 and 2), and the complexity of individual task-sets (Experiments 3-6) in a task-cueing paradigm.

In Experiments 1 and 2, participants switched among three or five tasks, in separate sessions. There was no effect of the number of tasks on the switch cost, or its reduction with preparation, provided that recency and frequency of task usage were matched. When recency and frequency were not matched, there appeared to be a larger switch cost with five tasks at a short preparation interval, suggesting that the time consumed by getting a task-set into a most active state is influenced by its recency and frequency of usage, not the number of alternatives per se.

However, Experiment 3 showed that the time required to select an S-R mapping within a task-set does increase as a function of the number of alternatives (even when stimulus frequency and recency are matched), suggesting that representation of the most active task-set in a PWM buffer is subject to a strict capacity limit. Experiments 4-6 further investigated the capacity limit of this PWM buffer, and found that task-set preparation was more effective for task-sets that are less complex (i.e. specified by fewer S-R rules). These findings suggest that only very few S-R rules can be maintained in a most active state in the PWM buffer.

Finally, Experiments 7-9 investigated whether S-R rules are represented phonologically for task-set maintenance and preparation, by manipulating the phonological properties of the stimulus terms. But task-cueing performance was not affected by the name length (Experiment 7) or phonological similarity (Experiments 8 and 9) of the stimulus terms. These results suggest that phonological representations of S-R rules do not make a functional contribution to task-set control, possibly because the rules are compiled into a non-linguistic PWM.

The results of these experiments are discussed in terms of a procedural working memory which is separate from declarative working memory, and distinguishes between two levels of task-set control: the level of task-sets, which are maintained in a capacity unlimited state of representation, and the level at which the currently relevant task-set is maintained in a most-active but highly capacity limited state of representation.

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Declaration

The research reported in this thesis was carried out at the University of Exeter between October 2008 and May 2012, and was supervised by Prof. Stephen Monsell and Dr. Aureliu Lavric.

This dissertation has not been submitted, in whole or in part, for any other degree, diploma or qualification at any university. Chapters 2 and 5 are articles that will be submitted to scientific journals. Chapter 2 will be submitted to Journal of Experimental Psychology: Human Perception and Performance by van ‘t Wout, F., Monsell, S., and Lavric, A. I conducted the experiments, wrote the first draft and prepared the figures and tables. My co-authors have edited the manuscript. Chapter 5 will be submitted to Journal of Experimental Psychology: Learning, Memory and Cognition. I conducted the experiments, wrote the first draft and prepared the figures and tables. My co-authors have edited the manuscript.

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Félice van ‘t Wout
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