The temporal dynamics of switching tasks

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Abstract

The topic of this thesis is cognitive control: how the brain organises itself to perform the many tasks it is capable of and how it switches flexibly among them. Task-switching experiments reveal a substantial cost in reaction time and accuracy after a switch in tasks. This "switch cost" is reduced by preparation (suggesting anticipatory task-set reconfiguration), but not eliminated. The thesis focuses on the sources of the "residual" cost. Most accounts attribute it to response selection being prolonged on a task-switch trial by task conflict, e.g. by 'task-set inertia' — persisting activation/inhibition of the previous task's S-R rules — or their associative reactivation by the stimulus.

Four experiments used event-related potentials (ERPs) to determine which stages of task processing are influenced by a change in tasks, looking for delays in process-specific markers in the ERP. Experiments 1 and 2 showed that a prepared switch to a reading task from a perceptual judgement delayed early ERP markers of lexical access by a large fraction of the RT switch cost, suggesting that a substantial part of the residual cost arises in processes earlier than response selection, possibly due to task-related attentional inertia. Markers of lexical access observed in the non-lexical task were larger on switch than repeat trials, providing the first electrophysiological evidence of task-set inertia. Experiment 3 examined the effects of an unprepared switch in the same way. ERP waveforms were modulated by a switch before markers of lexical access were evident, suggesting additional processing demands compete for resources with lexical access. A simple delay, however, was not found; post-stimulus task-set reconfiguration does not just insert an extra processing stage. Experiment 4 looked for a delay in the onset of an early ERP marker of emotional processing when the task switched between categorising facial expression and classifying a superimposed letter. No such delay was found in this case, and ERP markers of emotion processing were present to the same extent in the letter task. This suggests that, given appropriate spatial attention, processing facial emotion unfolds automatically, independent of attention allocation to the facial features.
Experiments 5-7 further explored the link between conflict due to processing the irrelevant stimulus dimension and the ERP post-stimulus negativity that accompanies the residual cost. The negativity could be elicited even on trials of non-switching blocks by prior training on classifying the irrelevant attribute of the stimulus using the same responses. But this effect did not seem to result from the trained class of irrelevant attribute attracting more attention.

Finally, Experiment 8 followed up an incidental observation in Experiment 1 to establish the novel observation that a task-switching context abolishes the usual ERP correlate of withholding a response in a go/no-go paradigm, suggesting an interesting interaction between task-set control and response inhibition.
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