COGNITIVE NEUROSCIENCE

Pause for thought

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Making split-second decisions and multitasking are part of a daily routine for many people. But even those that are accomplished at juggling many things at once would pause momentarily when challenged to carry out two tasks at the same time. Now, writing in *PLoS Biology*, Sigman and Dehaene suggest a cognitive architecture that could explain the complex dynamics behind task prioritization.

Choosing which task to complete first when we are bombarded with two tasks simultaneously or close together is a complicated decision. A classic model in psychology — the passive bottleneck model — explains this process, at least for simple stimulus–response tasks, as the end result of three sequential steps in information processing: perception, decision and action. The decision stage is considered to be the central step. It is at

this stage that the two tasks compete to be processed, effectively forming a single-file queue that progresses in an orderly manner, without any delays and with no detrimental effect on the response time to initiate the first task. However, the literature suggests that this is an overly simplistic description of task-switching dynamics. In earlier research, Sigman and Dehaene established that when presented with two tasks (one auditory and one visual) and instructed which task to complete first, participants' response times for the first task were slower than those when challenged with only the first task.

To shed light on the complex dynamics in task switching, the authors used the same dual-task test, but this time participants were allowed to choose which task to tackle first. This change enabled the authors to focus on the effect of task switching but incorporate the aspect of task simultaneity from the passive bottleneck model. The authors introduced another level of uncertainty by varying the order of first-task presentation and the length of time between presentation of the two tasks. For the auditory test, participants were asked to determine whether a frequency was high or low and to respond solely with their left hand. The visual test involved participants having to decide whether a number was greater or smaller than 45 (respond with right hand), with variation being introduced in the notation (words or Arabic digits) and numerical distance from the set number.

Typically, when the task order is specified, the length of time

between presentations has no effect on the reaction time to the first task. Interestingly, the authors found that when participants could choose which task to prioritize, presentation of the two tasks in rapid succession (less than 400 ms) increased the time taken to respond to the first task. The authors propose that this delayed response can be attributed to an additional active task-prioritization processing stage, which leads to the proposal that task selection occurs through a bottom-up mechanism, with all the information being considered before commitment to a certain action.

According to the passive bottleneck model, the second task is started immediately after completion of the first task. However, discrepancies between results in the test involving variations in numerical distance in the number task with results from earlier experiments led the authors to suggest that the second task can be started only when the motor stage of the first function has been completely disengaged.

The model presented by Sigman and Dehaene amalgamates concepts from the task-switching and passive bottleneck models, and so presents a strong foundation on which to build functional brain imaging studies to identify the specific pathways and areas of the brain that are involved in information processing.

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ORIGINAL RESEARCH PAPER Sigman, M. & Dehaene, S. Dynamics of the central bottleneck: dual-task and task uncertainty. *PLoS Biol.* **4**, e220 (2006)