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The role of inner speech in task switching: A dual-task investigation

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Abstract

This dual-task study examined the role of inner speech in task switching. Experiment 1 demonstrated that disrupting inner speech via articulatory suppression dramatically increases switch costs. The three subsequent experiments attempted to specify the role of inner speech in task switching by introducing additional manipulations (i.e., types of cues in Experiment 2, task difficulty in Experiment 3, and the number of tasks switched between in Experiment 4) and then examining whether these factors modulated the magnitude of the articulatory suppression effect on switch costs. Only the cue type manipulation—hypothesized to affect the degree to which participants rely on verbal self-instruction—modulated the articulatory suppression effect, suggesting that inner speech serves as an internal self-cuing device by retrieving and activating a phonological representation of the upcoming task.

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Although the ability of people to perform one task and then switch to another has been under investigation at various times for the past three-quarters of a century (e.g., Botwinick, Brinley, & Robbin, 1958; Jersild, 1927; Spector & Biederman, 1976), this topic did not become a target of intensive empirical and theoretical inquiries until the middle of the last decade (e.g., Allport, Styles, & Hsieh, 1994; Fagot, 1994; Meiran, 1996; Rogers & Monsell, 1995). The dominant result found in virtually every task switching study is that switching from one task to another (e.g., from task B to task A) results in a significant increase in time (or sometimes errors as well) compared to performing the same task on successive trials (e.g., performing task A twice). This difference between the reaction times (or errors) required for task-switch and task-repeat trials is called the *switch cost*, and

many researchers have attempted to specify its nature and origins to uncover the mechanisms underlying task switching performance and, more generally, executive control (for an overview, see a collection of articles in Monsell & Driver, 2000).

Although this resurgence of task switching studies has taken place only recently, it is now clear that the process of switching between two tasks is highly complex and that many perceptual, cognitive, and response-level factors can influence the magnitude of switch costs. Some of the factors that have so far been examined in detail include (but are not limited to) the preparation time, task congruency, and response repetition (e.g., Fagot, 1994; Gopher, Armony, & Greenspan, 2000; Meiran, 1996, 2000; Rogers & Monsell, 1995). Although the effects of these factors on switch costs are relatively well established, other factors contributing to task switching performance have received relatively little attention. In the present study, we focused on one such neglected component, namely, *inner speech*, and examined its role in task switching performance.

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The idea that inner speech plays a role in task switching may sound rather odd, given that inner speech is not usually associated with executive control processes. For example, consider the traditional model of working memory proposed by Baddeley (1986); (Baddeley & Logie, 1999). Within this model, inner speech is associated with the *phonological loop* system, which is considered to be a peripheral, independent component (or “slave” system) of working memory specialized for the short-term storage and processing of verbal-phonological information, including maintenance rehearsal. In particular, one of its subcomponents, called the *articulatory control* (or *articulatory rehearsal*) process, is assumed to underlie the generation of inner speech or internal subvocalization (Baddeley & Logie, 1992). Within this framework, the phonological loop—and inner speech by association—has virtually nothing to do with executive control processes because it can only deal with verbal-phonological processes and because executive control is considered to be handled by a central attentional control structure called the *central executive*. Thus, from the perspective of this model, it may seem highly unlikely that inner speech plays a role in task switching.

Over the last few years, however, we have been struck by the fact that many participants who took part in task switching experiments in our laboratory reported using a strategy of covert self-instruction via inner speech (i.e., covertly articulating to themselves which task to perform next) to help them switch between tasks. Consistent with this anecdotal evidence, two recent studies suggest the involvement of inner speech in task switching performance (Baddeley, Chincotta, & Adlam, 2001; Goschke, 2000).

In one study (Goschke, 2000), participants performed simple color judgment and letter judgment tasks on the computer and were given a long interval (1500 ms) between the previous response and presentation of the next stimulus to prepare for the upcoming task. During this preparation interval, some participants were asked to say the task name aloud once (e.g., “color” or “letter”), whereas other participants were asked to say an irrelevant word once (e.g., “Monday” or “Tuesday”). The main result from this manipulation was that the switch cost was substantially smaller among participants who said the task name than among those who verbalized an irrelevant word. In fact, the switch cost for participants who verbalized the task name was virtually identical to the cost for participants who had a long preparation interval without any verbalization requirement, whereas the switch cost for participants who verbalized an irrelevant word was similar to the cost observed for participants who received a short preparation interval of only 14 ms. These findings suggest that the opportunity to verbally remind oneself which task to perform next may indeed be an effective strategy to prepare for the forthcoming switch.

A second study (Baddeley et al., 2001) more directly examined the involvement of inner speech using the list paradigm originally developed by Jersild (1927). Participants in this study completed several lists of addition and subtraction problems in blocked form (i.e., addition only or subtraction only) or in alternating form (i.e., alternating between addition and subtraction). They performed this simple paper-and-pencil arithmetic task by itself or in combination with various secondary tasks. As they had predicted, concurrent performance of a complex secondary task that required explicit category switches, such as interleaving the days of the week with the months of the year (e.g., saying “January, Monday, February, Tuesday, March...”), slowed performance on the alternating lists more than the blocked lists. More surprising was the finding that a simpler task of reciting a familiar sequence (e.g., saying “Monday, Tuesday, Wednesday...” or “January, February, March...”) also negatively affected the ability of participants to switch between the addition and subtraction tasks, although the increase in switch costs was not as large as that observed for the interleaving task (Experiment 2). Such negative effects of concurrent articulation on switch costs were still significant even when a simpler, more common version of articulatory suppression (e.g., saying “the” repeatedly) was used in later experiments (Experiments 6 and 7).

Although the results from both of these studies point to the role of inner speech in task switching, they also raise a number of questions that need to be answered. For example, does the switching impairment associated with articulatory suppression go beyond the general decrement often observed when two tasks are performed simultaneously? If so, what role does inner speech play? Why is inner speech useful in task switching performance? To address these questions, we conducted a series of four dual-task experiments that systematically examined the effects of articulatory suppression on task switching performance.

All four of the experiments reported in this paper employed the paper-and-pencil version of the list paradigm developed by Jersild (1927). Admittedly, this list paradigm is limited in a number of important respects (see Rogers & Monsell, 1995, for a discussion on this issue). For example, the measurement technology used for the list paradigm is typically crude (e.g., measured with a stopwatch by the experimenter) and only provides global aggregate measures (e.g., completion times for individual lists); thus, it is impossible to obtain the precise timing for each individual item on the list. In addition, the motor requirement of writing down the answers necessarily constrains the response rates (i.e., people may be able to solve simple arithmetic problems faster than they can write down the answers). Given that the entire list of items is visible, participants can preview the next item on the list and start processing it while writing down

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