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Transformation of task components into an integrated representation during task switching

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Abstract

We combined task switching with a change paradigm to trace the transformation of the information conveyed by task cues into a readiness to perform the cued task. The tasks were composed of two components that allowed us to determine switch costs as a function of the number of changed task components. With a short stimulus-onset asynchrony (SOA) of 200 ms, switch costs grew monotonically as a function of the number of changed components. With a SOA of 400 ms, the switch-cost profile exhibited a nonmonotonic characteristic that was previously observed only with switches from an already performed task. Our observations suggest that task preparation can be considered as a process by which an unstructured representation of task components is gradually transformed into an integrated task representation that comprises asymmetrical associations between the task components.
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0. Introduction

In task-switching experiments, participants are asked to perform different tasks in close succession. In case of having performed a task in trial $n-1$ (task A) that differs from the task to be performed in trial n (task B), some transformation has to take place that changes the cognitive systems' readiness to perform task A into a readiness to perform task B. To

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detail the way in which this transition is accomplished is one of the most important objectives of research on task switching.

The perhaps intuitively most obvious possibility is that the transition from task A to task B is functionally associated with an exchange of active task sets (cf. Mayr & Kliegl, 2000). Such an exchange could consist of a literal replacement of the contents of working memory or a gradual transition from a readiness to perform task A to a readiness to perform task B. In either case, there is at least one constraint that should be met to corroborate any notion of a transition from task A to task B in terms of an exchange of active task sets: There should be a reciprocity with respect to the effects of a readiness to perform task A and a readiness to perform task B. For example, when you cease from preparing a lecture in order to discuss a new experiment with a colleague, as the details of the experiment gain strength as contents of your working memory, the contents related to the lecture should fade away. Thus, any indication that the readiness to perform a new task increases should be accompanied by a decreased readiness for the task you performed before.

Unfortunately, things may not be so simple. In a recent study (Kleinsorge, Gajewski, & Heuer, 2005), we provided evidence that preparation for a new task can proceed without affecting the readiness to perform the task that was carried out in the trial before. In this study, the new task was indicated by precues which were sometimes incorrect. To assess the impact of the precued task independent of the effects of the previously performed task, we used tasks that consisted of two components that were precued with imperfect validity. In such a setting, two tasks can differ from one another with respect to either one of the two components or with respect to both components. In addition, two tasks can be the same when both components repeat. When participants switch among this set of tasks, switch costs vary in a regular fashion as a function of the relation between an old and a new task (cf. f.e. Kleinsorge, 2004; Kleinsorge & Heuer, 1999; Kleinsorge, Heuer, & Schmidtke, 2001a). Thus, there is a certain *profile of switch costs* that is specific for particular *inter-task relations* in terms of the (mis)match of individual task components (for details, see below).

By using sometimes incorrect precues, the task of trial *n* can not only differ from the preceding task, but also from the task that was precued for trial *n*. Again, these two tasks can differ from one another with respect to either no, one, or both task components (*precue-to-task relation*).

The empirical approach of Kleinsorge et al. (2005) was to factorially vary the inter-task relation and the precue-to-task relation. In addition, they varied the precueing interval (PCI) to manipulate the time available to prepare for the precued task. The crucial observation of Kleinsorge et al. (2005, Exp. 1 and 2) was that the effect of the inter-task relation was unaffected by the PCI, while at the same time massive costs induced by incorrect precues showed up that varied as a function of the PCI. This pattern of results violates the assumption of a reciprocity regarding the readiness to perform a preceding task and the readiness to perform a new task. That is because the increasing activation of the precued task (as indexed by the increase of miscuing costs as a function of the duration of the PCI) was not accompanied by a decreasing activation of the previously performed task (as indexed by the lack of modulation of the effect of the inter-task relation as a function of the duration of the PCI), as would be expected when both tasks compete for being represented in the same medium (e.g., working memory). The lack of reciprocity with respect to the effects of the inter-task relation on the one hand and the precue-to-task relation on the other hand also casts some doubt on the interpretation of residual switch costs. Operationally, residual switch costs are defined as switch costs that remain despite the possibility for advance task