On the role of dissipating inhibition in task switching

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Running Head: Dissipating inhibition in task switching

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Abstract

The n-2 repetition cost has been explained by persisting inhibition of a previously valid task set which dissipates over time. This account has two implications, namely that the switch cost decreases with the number of tasks involved in switching and that the cost should also be observed in switching between two tasks. Neither of these implications is supported by empirical evidence. An alternative view is briefly discussed.

Keywords: task switching, lag-2 repetition cost, inhibition

The lag-2 repetition cost in switching between three tasks (Mayr & Keele, 2000) is a robust phenomenon (see Koch, Gade, Schuch, & Philipp, 2010, for a review). With tasks labeled A, B, and C, this cost consists of a slower reaction time (RT) on ABA than on CBA sequences. To account for this finding Mayr and Keele (2000) assumed that the irrelevant task-set is inhibited and that there is more "residual" inhibition left because the A task was more recently inhibited in the ABA than in the CBA sequence. Many researchers believe this observation provides the best empirical support for the role of inhibition in task switching, even though the lag-2 repetition cost can be explained in different ways (Koch et al., 2010). In the account proposed by Mayr and Keele (2000), two assumptions are made: (1) switching requires inhibition of the active task set, and (2) the inhibition effect is temporary. In fact, only the latter assumption accounts for the difference between ABA and CBA sequences. The purpose of the present paper is to critically reflect on this particular assumption and its empirical validity.

The role of inhibition itself is not at issue here. The focus is completely on the assumption that the inhibition once applied in some way diminishes or dissipates. This assumption implies that if the present task set is inhibited when a task switch occurs, and this inhibition diminishes over time, a lag-2 repetition cost should be present irrespective of the number of tasks involved. In what follows, this implication is further elaborated and confronted with empirical data.

Switching among many tasks

In a procedure with four tasks, three types of (switch) sequences can be considered, namely the lag-2 repetition sequence (e.g., CABA), a lag-3 repetition sequence (ACBA) and sequences with no repetition of a task over four trials (DCBA). If inhibition dissipates over time, RTs are expected to be slower in CABA than ACBA sequences and slower in ACBA than DCBA sequences. Because the lag-2 and the lag-3 repetition sequences are common with the three-task procedure, and the DCBA sequences are faster than each of these, the average RT over all these types of switch trials is expected to be smaller in the four-task than in the three-task procedure, Assuming that tasks of equal difficulty are used in three- and four-task procedures, the difference between task switches and task repetitions is expected to be smaller in the four-task than in the three-task procedure. In other words, the more tasks among which one has to switch, the smaller the cost of switching would tend to become. This is in contradiction however to many of the findings reported in the literature, as some studies report increased switch costs when more tasks are involved (e.g., Buchler, Hoyer, & Cerella, 2008; Kleinsorge & Apitzsch, 2012), whereas others did not find any differences (e.g., da Silva Souza, Oberauer, Gade, & Druey, 2012). In fact, when task frequency and recency are controlled for, the switch cost does not differ with the number of tasks in play (Van 't Wout, Monsell, & Lavric, in preparation). All these findings are in contradiction with a prediction of a decreasing switch cost with number of tasks.

Switching among two tasks

The ABA sequence also occurs in switching between two tasks. Hence it should be possible to observe the lag-2 repetition cost in this situation as well, provided a proper comparison sequence can be found. Based on the findings of Gade and Koch (2005), BBA is the appropriate comparison sequence. To my knowledge, no relevant data have been published. Therefore, I present here data from two unpublished experiments that were part of a study pursuing the cue-task transition-congruency conflict (Van Loy, Liefooghe, & Vandierendonck, 2010).

The data are from a condition with explicit cues with either a manual (Experiment 1) or a vocal (Experiment 2) task identification response before target onset, to separate cue processing from target processing. The task sequences contained equal numbers of four kinds of task triplets (AAA, BAA, ABA, and BBA). The execution RT analysis excluded error trials and trials following an error.

The task-switch cost was large in both experiments (95 ms, $F(1,14) = 19.1$, $p < .001$, $\eta_p^2 = .58$ in Experiment 1; 74 ms, $F(1,17) = 27.8$, $p < .001$, $\eta_p^2 = .62$ in Experiment 2), but the lag-2 repetition cost (difference between ABA and BBA sequences) was very small (respectively

3 ms and 7 ms; both $F < 1$, $\eta_p^2 = 0$). This finding does not allow to reject the null hypothesis and this was clearly not due to lack of statistical power.

In fact, what varies between the two compared sequence types is the number of repetitions of the B-task before the switch to A, namely 0 repetitions in ABA and 1, 2 or more in BBA. With more repetitions, the time since the A-task was inhibited increases, and it follows that the switch cost should be smaller with more repetitions (less residual inhibition). This prediction was tested on the data of the same experiments.

The observed mean RTs for sequences with 0, 1, or 2 repetitions were 749, 760 and 741 ms in the first, and 633, 622 and 623 ms in the second experiment. Neither the contrast between 0 and 1 nor the contrast between 0 and 1 or 2 repetitions were reliable (all $F < 1$).

Taken together these data suggest that dissipation of inhibition over trials does not contribute to the task switch cost in two-task switching. Neither a strict lag-2 repetition test, nor a comparison based on the number of repetitions of the B task intervening between the two A tasks revealed any reliable RT difference. Importantly, these findings are observed in experiments that disentangled task-related and cue-related processing by using separate registration of cue- and task-related responses. Confirmation of these results by other experimentation would of course be most welcome.

Conclusion

Elaboration of an implication of the hypothesis of dissipating inhibition shows that it is difficult to defend this hypothesis as an account of the lag-2 repetition cost in switching among three tasks. In fact, the finding that the lag-2 repetition cost decreases when task repetitions are included in the experiment (Philipp & Koch, 2006) also casts doubt on such an account. A possible alternative explanation would be that the cost is due to strategic choices, such as biasing task-set retrieval or trusting expectations about task sequences (but see Koch et al., 2010). Another possibility is temporal distinctiveness drives the lag-2 repetition cost (Horoufchin, Philipp, & Koch, 2011). Future research is needed to achieve a final say in this debate.

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