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Conflict adjustment devoid of perceptual selection☆,☆☆

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ABSTRACT

Task performance suffers when an aspect of a stimulus is associated with an incorrect response, thereby evoking cognitive conflict. Such impairment is reduced after recent or frequent conflict occurrence, suggesting attentional adjustment. We examined adjustment to conflict evoked by a temporarily irrelevant S–R rule when participants frequently switched between two semantic classification tasks by manipulating the proportion of conflict trials in one of them. Controlling stimulus-specific presentation frequencies, we found reduced conflict effects under conditions of a higher proportion of conflict trials in the task to which the manipulation was applied, whereas there was no such effect in the other task. Additional analyses demonstrated task-specificity regarding trial-to-trial conflict adjustment. Because conflict was evoked in the absence of perceptually distinct target and distractor stimulus features, these adjustment effects cannot be attributed to perceptual selection.

1. Introduction

Conflict paradigms have yielded abundant evidence for cognitive processing of stimulus aspects which are irrelevant to a current task (i.e., which contain only information not necessary for correct task performance), even if participants have full knowledge about this irrelevance and are instructed to ignore them. Prominent demonstrations of this can be seen in relative performance impairment when a distractor stimulus feature, such as a word in the Stroop task (Stroop, 1935), a stimulus object adjacent to the target stimulus in the Eriksen flanker task (Eriksen & Eriksen, 1974), or the stimulus location in the Simon task (Simon & Small, 1969), is associated with an incorrect response, suggesting distractor-related response activation that interferes with responding to the target stimulus feature.

Such response conflict effects are reduced after recent or frequent processing of conflict stimuli (i.e., stimuli involving a distractor feature associated with an incorrect response) (e.g., Fernandez-Duque & Knight, 2008; Gratton, Coles, & Donchin, 1992; Wendt & Luna-Rodriguez, 2009). These modulations have been ascribed to attentional adjustment, that is, variations of the degree of dominance of processing target over distractor stimulus information, as a consequence of conflict experience (Botvinick, Braver, Barch, Carter, & Cohen, 2001) or, more generally, as a function of distractor utility (Gratton et al., 1992).

So far, little attempts have been made to specify the stages of processing which are affected by conflict adjustment. In paradigms as the ones mentioned above, in which target and distractor stimulus information is presented in the form of physically distinct stimulus features, perceptual selection, that is, re-distributing attentional weights assigned to the processing of these features, seems a likely means of adjustment. Support for this assumption has been obtained by using a visual search task, intermixed into blocks of flanker task trials, to probe the processing weights given to target- and flanker-related perceptual features. More precisely, Wendt, Luna-Rodriguez, and Jacobsen (2012) administered a traditional version of the flanker task (Experiment 1), in which a target letter was presented at the center of the screen, flanked on either side by identical copies of the same or of a different letter. On intermixed search task trials, participants had to detect a target digit in a string of three digits which occurred at the same locations as the letters in the flanker task. The location of the search task target varied randomly among the three possible locations. Search task reaction times (RTs) were generally shorter when the target was presented at the central location (i.e., at the location of the target of the flanker task) than when it was presented at one of the flanker locations. Crucially, this center-to-periphery gradient was more pronounced when the proportion of flanker task trials associated with

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response conflict was higher. A similar result was obtained in another experiment (Experiment 2) with a modified flanker task, in which target and distractor were defined by their colors rather than their locations, and a correspondingly adjusted search task was used (i.e., a search task in which the target and the distractor digits were randomly assigned to the two colors of the flanker task stimuli).

Although these findings demonstrate conflict-induced enhancement of selection based on perceptual target- and distractor-related features, inferring conflict adjustment at the stage of stimulus encoding may be premature because Wendt et al.'s (2012) data do not allow to dismiss the possibility that perceiving the distractor-related stimulus feature elicits retrieval of "don't respond tags", attached to this feature on previous flanker task trials, which may interfere with current response demands (Neill, Valdes, Terry, & Gorfein, 1992). Noteworthily, the two interpretations differ regarding the functionality attributed to the mechanism underlying the performance pattern found in the search task. Whereas perceptual filtering could be regarded as a strategic measure, serving to reduce conflict emergence on future occasions, the episodic memory view would consider the pattern of search task results to be a by-product of automatic integration and retrieval processes.

However, other possible non-perceptual mechanisms of conflict adjustment than episodic retrieval of response information are conceivable. Firstly, it could be assumed that processing weights assigned to conceptual rather than perceptual categories are modified as a result of conflict occurrence. Putting larger weight on task-relevant conceptual categories may be assumed to reduce the build-up of conflict in an analogous manner to enhanced perceptual selection. Secondly, later processes of conflict resolution may gain efficiency through previous application, thereby possibly facilitating responding in conflict trials after recent or frequent conflict processing, even if early stimulus–response translation processes and conflict build-up remain unaffected.

In the current study, we looked for evidence for conflict adjustment devoid of perceptual selection, presumably taking place at a post-perceptual processing stage. To this end, we set up conflict conditions in which target and distractor information is not presented in terms of perceptually distinct stimulus features. This can be achieved by asking participants to alternate between two different classification tasks comprising semantic judgments, such as classifying a stimulus digit as odd or even on some trials and as smaller or larger than 5 on other trials, while using the same set of responses for both tasks.[1] With such an arrangement (e.g., pressing a key on the left side for *odd* and *smaller*, and pressing a key on the right side for *even* and *larger*) some stimuli are associated with the same response in both tasks (henceforth *congruent*, e.g., for the above S–R assignment, 1 or 6), whereas other stimuli are associated with different responses regarding the two tasks (henceforth *incongruent*, e.g., 2 or 7). By consequence, congruency effects (i.e., the performance difference between responding to a congruent and an incongruent stimulus) reflect some form of application of the S–R rules of the currently irrelevant task (see e.g., Kiesel et al., 2010, for a review of conflict effects in task switching studies).

Preliminary evidence for non-perceptual conflict adjustment was obtained by Kiesel, Kunde, and Hoffmann (2006). Applying a task switching paradigm as described (i.e., parity vs. magnitude judgments on digit stimuli), these authors found a reduced congruency effect after an incongruent as compared to a congruent predecessor trial when the task repeated from the preceding trial (thereby replicating the above mentioned trial-to-trial modulation found in single-task conflict paradigms). In contrast, the congruency effect was unaffected by the congruency level of the preceding trial when the task alternated, suggesting that conflict adjustment takes place in a task-specific manner.[2]

This task-specificity accords with other demonstrations of context-dependency of conflict adjustment effects. For instance, Spapé and Hommel (2008) using an auditory Stroop-like task found a reduced congruency effect after an incongruent predecessor trial if the voice in which the distractor stimulus was presented remained the same between trials but not if the voice switched between trials, suggesting that attentional settings can be bound to task-irrelevant contextual features. Regarding adjustment to conflict frequency, several studies in which the ratio of congruent and incongruent trials was correlated with an additional task-irrelevant stimulus feature (e.g., two stimulus locations, associated with different congruent/incongruent ratios) found a smaller congruency effect in trials with the contextual feature associated with a lower ratio (e.g., Corballis & Gratton, 2003; Crump, Gong, & Milliken, 2006; Crump & Milliken, 2009; Crump, Vaquero, & Milliken, 2008; King, Korb, & Egner, 2012; Wendt & Kiesel, 2011; Wendt, Kluwe, & Vietze, 2008).

Although some models of cognitive control attribute the trial-to-trial modulation and the congruency ratio-based modulation to the same mechanism (e.g., Botvinick et al., 2001; Gratton et al., 1992; Verguts & Notebaert, 2008, 2009), some recently reported dissociations between the two effects support the notion that they are brought about by different types of adjustment (e.g., Fernandez-Duque & Knight, 2008; Funes, Lupiáñez, & Humphreys, 2010; Purmann, Badde, & Wendt, 2009; Torres-Quesada, Funes, & Lupiáñez, 2013; Wendt et al., 2012). For instance, Funes et al. (2010) manipulated the proportion of Simon conflict trials in a combined Simon and Spatial Stroop task and found reductions of both the Simon effect and the spatial Stroop effect under conditions of a higher (Simon) conflict proportion in the absence of any trial-to-trial modulation between the two types of conflict, thus suggesting conflict-type-specific adjustment to individual conflict events and generalized adjustment across conflict types to a list-wide conflict manipulation.

Some framework conceptions of cognitive control emphasize a distinction of transient and more sustained control implementations, brought about by different types of processes and neural correlates (e.g., Braver, 2012; see also Dosenbach, Fair, Cohen, Schlaggar, & Petersen, 2008), and this distinction has been linked to the two phenomena of trial-to-trial and congruency ratio modulations of the congruency effect in conflict tasks (De Pisapia & Braver, 2006; Funes et al., 2010). Specifically, Braver (2012) assumed, on the one hand, a reactive control mechanism to resolve interference after its onset, recruited by the detection of high interference events (e.g., through the engagement of conflict monitoring brain regions), and associated with transient activation of lateral prefrontal cortex and other brain areas. On the other hand, he proposed a mechanism of proactive control, reflecting active maintenance of goal-relevant information and characterized by sustained activation of lateral prefrontal cortical areas. Consistent with the idea of a sustained nature of the congruency ratio modulation of the congruency effect, Torres-Quesada et al. (2013) demonstrated transfer to subsequent blocks of trials (i.e., a larger congruency effect after practice with a higher congruent/incongruent ratio).

[1] Although it is theoretically possible that participants cope with such demands by focusing on different perceptual aspects of one and the same stimulus, depending on the current task, we deem such ad-hoc generation of perceptual dimensions unlikely.

[2] Unlike the congruency effect, task switch costs (i.e., worse performance on task alternation trials than on task repetition trials) were affected by the congruency level of the preceding trial. More precisely, responding on task alternation trials was selectively impaired after an incongruent predecessor trial whereas there was no corresponding effect on task repetition trials. This pattern of results had earlier been observed when participants switched between tasks which were afforded by different perceptual stimulus dimensions (i.e., letter vs. color identification, Goschke, 2000). Assuming inhibited processing of a (previously) conflicting stimulus dimension, Goschke labeled the effect dimension negative priming. The fact that the effect also occurs in make-ups such as Kiesel et al.'s (2006), in which tasks are not associated with distinct perceptual features, demonstrates that it might also be accounted for in terms of inhibition of non-perceptual task-set components.