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Context-specific control and context selection in conflict tasks

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ABSTRACT

This study investigated whether participants prefer contexts with relatively little cognitive conflict and whether this preference is related to context-specific control. A conflict selection task was administered in which participants had to choose between two categories that contained different levels of conflict. One category was associated with 80% congruent Stroop trials and 20% incongruent Stroop trials, while the other category was associated with only 20% congruent Stroop trials and 80% incongruent Stroop trials. As predicted, participants selected the low-conflict category more frequently, indicating that participants avoid contexts with high-conflict likelihood. Furthermore, we predicted a correlation between this preference for the low-conflict category and the control implementation associated with the categories (i.e., context-specific proportion congruency effect, CSPC effect). Results however did not show such a correlation, thereby failing to support a relationship between context control and context selection.

1. Introduction

Acting in a volatile environment involves flexibly adapting one's behaviour following sudden changes or conflict. For instance, when the road to the supermarket is blocked, we will make a detour so that we can still arrive at our intended destination. Our cognitive system is thus able to react to conflicting situations by modifying task settings in such a way that goal-directed behaviour can be further pursued, an ability referred to as cognitive control.

In research on cognitive control, congruency tasks are often used to induce conflict. One example is the Stroop task (Stroop, 1935), in which participants have to name the ink colour of a colour word and ignore the irrelevant word information. Conflict is present in incongruent trials (e.g., the word RED written in green), resulting in longer and more error-prone responses, than to congruent trials (e.g., the word RED written in red). Over the last decade, an extensive research domain has developed specifically investigating the characteristics of conflict processing, showing for instance how control implementation is increased after incongruent trials (i.e., conflict adaptation effect; for a review, Egner, 2007), and when the proportion of incongruent trials is high (i.e., proportion congruency effect; for a review, Bugg & Crump, 2012).

Yet, an important question remains whether conflict not only modifies task performance but also influences choice behaviour. It is plausible that we might opt for another supermarket in the future so as to avoid the conflict and cost of making a detour. It has been put forward that conflict is registered as a negative event (Botvinick, 2007), making it likely that decision-making might be altered away from the (negative) conflict choice alternative (i.e., conflict avoidance hypothesis). Recent evidence supports the assumption that conflict has a negative valence. For instance, using an affective priming paradigm, Dreisbach and Fischer (2012) showed that participants were faster to evaluate negative targets (pictures or words) when these stimuli were preceded by incongruent Stroop primes relative to congruent Stroop primes (see also Fritz & Dreisbach, 2013; Schouppe et al., submitted for publication). More indirect evidence for the negative nature of conflict came from a study of Lynn, Riddle, and Morsella (2012), showing that participants reported a greater urge to quit the task at hand (i.e., Stroop task) after incongruent stimuli. Also, Schouppe, De Houwer, Ridderinkhof, and Notebaert (2012) found that the stimulus congruency effect disappeared when participants carried out an avoidance response, indicating that on conflict trials avoidance is the more likely response.

In order to investigate whether conflict influences decision-making, we developed a conflict selection task. In this task, participants were asked to choose between two categories. Crucially, conflict frequency was manipulated between the two categories, with one category having 80% congruent trials and 20% incongruent trials (i.e., low-conflict category) and the other category having 80% incongruent trials and 20% congruent trials (i.e., high-conflict category). Our conflict selection task is adapted from the demand selection task (Botvinick, 2007; Kool, McGuire, Rosen, & Botvinick, 2010), in which the degree of task

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switching was manipulated between two choice options. Results from the demand selection task showed a bias away from the option entailing a high degree of task switching, which was interpreted as reflecting avoidance of cognitive demand. Therefore, we predicted that in our conflict selection task participants would prefer the low-conflict category, thus showing that demand avoidance extends beyond task switching to conflict avoidance.

Importantly, using the conflict frequency manipulation, we can also estimate the amount of cognitive control associated with the two categories. Crump, Gong, and Milliken (2006) showed that when the frequency of incongruent trials is high in a particular context, more control is exerted, resulting in a smaller congruency effect in that context (i.e., context-specific proportion congruency effect; CSPC effect). Similarly, in our conflict selection task, we expected a smaller congruency effect for trials from the category associated with a high proportion of incongruent trials, indicating enhanced control implementation in that category (see also Bugg & Crump, 2012; Crump & Milliken, 2009; Heinemann, Kunde, & Kiesel, 2009; King, Korb, & Egner, 2012).

By using conflict as an inverse index of control, we can relate category-specific control to category preference. We hypothesised that the more control implementation is associated with one category compared to the other, the more participants want to avoid this category. We thus predicted a positive correlation between the low-conflict preference and CSPC effect.

2. Method

2.1. Participants

We expected a moderate correlation between the CSPC effect and low-conflict choice rate and therefore selected a large sample of one hundred subjects (range: 19–56 years of age; mean: 23 years of age; 87 female). All participants had a normal or corrected-to-normal vision. They provided written informed consent and were paid for their participation. The study procedures were approved by a local ethics committee and complied with relevant laws and institutional guidelines.

2.2. Materials

Subjects sat in a dimly lit, quiet room, facing a 17-inch monitor, with a viewing distance of approximately 50 cm. The experiment was run on a Pentium PC and stimulus presentation and response registration was done using Tscope software (Stevens, Lammertyn, Verbruggen, & Vandierendonck, 2006). The Stroop stimuli consisted of colour words (RED, YELLOW, BLUE or GREEN) in one of four possible colours (red, yellow, blue or green), presented in font courier bold, size 16. The vocal responses were detected by means of a Sennheiser MD 421-U-4 microphone, triggering an adapted voice key optimised for reaction time experiments (Duyck et al., 2008). The context was set by visual category cues: either a black square (9 cm height, 9 cm width) or a black diamond (diagonals 12.7 cm). The categories were presented in the middle of the screen and served as a background for the Stroop stimuli.

2.3. Procedure

The experiment consisted of two alternating phases, which we will refer to as the CSPC phase and the choice phase. In the CSPC phase participants performed a vocal Stroop task where the Stroop stimuli were from two categories. One category (low-conflict context) was associated with 80% congruent trials and 20% incongruent trials, while the other category (high-conflict context) was associated with only 20% congruent trials and 80% incongruent trials. Each trial started with the presentation of the category cue. After 1250 ms a fixation cross was displayed in the cue for 250 ms, followed by a Stroop stimulus. The stimulus remained on the screen until a response was given with a maximum reaction time of 1500 ms. When the voice key was triggered, the stimulus was tilted 20° to the right for 300 ms, after which the experimenter coded the response given by the subject. When the voice key was not triggered by the response of the participant or when the response deadline was already exceeded, the experimenter coded the trial as a miss. The inter-trial-interval was 1000 ms. The CSPC phase consisted of 160 trials. Trials from the low- and high-conflict categories were randomly mixed, with the restriction that they appeared equally often.

In the choice phase, a trial started with the presentation of two category cues, positioned to the left and right of the middle of the screen, with a distance of 10 cm between the cues. Participants had to indicate their choice by clicking on the category cue with the mouse, which was positioned in the centre of the screen, equidistant from the two cues. They were told that they could choose freely among the category cues and that, if they developed a preference for one category, they could always choose the preferred one. The presentation of the choice options on the screen (square left, rhombus right; square right, rhombus left) was random, but appeared equally often. After the choice, the category cue with the associated Stroop stimulus appeared. From then on, the trial was identical to that of the CSPC phase. In the choice phase, participants completed 80 trials.

The congruency status of the trials from the two categories was in both CSPC and choice phase randomly determined in blocks of 10 trials in order to assure that in every 10 trials of the category the congruent/incongruent ratio was established. This implementation allowed us to have some control over the congruent/incongruent ratio as participants chose freely between the two categories. Participants performed three alternating CSPC and choice phases, so that at the end of the experiment 480 CSPC trials and 240 choice trials were carried out. The assignment of the categories (square, rhombus) to the conditions (high-conflict, low-conflict) was counterbalanced across participants.

We used separate phases such that the CSPC effect and category preference could be independently assessed. The analysis of the CSPC effect was thus restricted to trials from the CSPC phases. Consequently, our measure of context-specific control implementation was not confounded with frequency of category cue presentation. Analyses showed that the CSPC effect did not change significantly along the three alternating phases, $p > .1$. When considering choice rates, results revealed a marginally significant effect of block, $F(2, 198) = 2.5$, $p = .085$, indicating that the preference for the low-conflict category was slightly more pronounced in the last choice phase (choice block 1: 65.6%, choice block 2: 66.5%, choice block 3: 69.6%). For the following analyses we merged the data of the three phases (for the CSPC and choice phase separately). However, the relationship between the CSPC effect and low-conflict preference separately for the three phases yielded similar results.

3. Results

3.1. Low-conflict preference

The mean choice rate for the low-conflict category above the high-conflict category was 67.2% (*SD*: 20.5%), which differed significantly from chance, $t(99) = 8.4$; $p < .001$. Participants thus displayed a consistent preference for the low-conflict category.

3.2. CSPC effect

For the analysis of the CSPC effect on reaction times, we removed the first trial of each block and performance errors (0.9% of total data). Furthermore, in some cases the voice key did not register the response of the participant (miss) or was triggered too early or too late (false alarm) because of the participant hesitating or hissing. These technical errors resulted in an additional exclusion of 16.2% of the data. A 2 (congruency: congruent vs. incongruent) $\times$ 2 (category: low-conflict vs. high-conflict) repeated-measures ANOVA was conducted on mean reaction times. Because the mean error percentage was very low