Brief article

Reward modulates adaptations to conflict

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Both cognitive conflict (e.g. Verguts & Notebaert, 2009) and reward signals (e.g. Waszak & Pholulamdeth, 2009) have been proposed to enhance task-relevant associations. Bringing these two notions together, we predicted that reward modulates conflict-based sequential adaptations in cognitive control. This was tested combining either a single flanker task (Experiment 1) or a task-switch paradigm (Experiment 2) with performance-related rewards. Both experiments confirmed that adaptations after conflict were modulated by reward. In the flanker task, this resulted in increased conflict adaptation after rewarded trials. In the task-switching experiment, reward increased the conflict-modulated switch cost. Interestingly, both adaptations to conflict disappeared after no-reward trials. Moreover, individual differences in participants’ sensitivity to reward predicted these reward modulations of trial-to-trial adaptations. These findings shed new light on the exact role of cognitive conflict in shaping subsequent behavior.

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1. Introduction

Daily routines are repeatedly interrupted by conflicts. Efficiently dealing with these conflicts is referred to as cognitive control. For instance, the sound of booing fans can interfere with a sports player’s actions, but subsequent adaptations to such interruptions assist us in maintaining our goals (i.e., winning the game). When it comes to reaching such goals, reward is a great motivator (Skinner, 1953); receiving a trophy will encourage us to efficiently repeat effective actions later. In this study, we investigate this influence of reward on cognitive control.

Cognitive control is typically studied with conflict tasks where irrelevant information slows down processing of relevant stimulus information. In the flanker task (Eriksen & Eriksen, 1974), where the central target is presented with either congruent (\texttt{>>>}) or incongruent (\texttt{<><}) flankers, participants respond faster on congruent trials, as compared to incongruent trials. Importantly, participants adapt their performance based on these incongruent trials. Gratton, Coles, and Donchin (1992) observed that there was a smaller flanker effect after incongruent than after congruent trials. Similarly, it has been demonstrated that cognitive conflict enhances the task-switch cost (Brown et al., 2007; Goschke, 2000), the decrease in performance associated with switching between two tasks, compared to repeating the same task. Participants showed larger task-switch costs after incongruent than after congruent trials.

According to the adaptation-by-binding model of Verguts and Notebaert (2008, 2009), both effects can be conceptualized as strengthening of associations due to conflict. In this model, conflict detection on incongruent trials increases task-relevant connections, increasing the focus on task-relevant information. By binding these associations after conflict, a smaller congruency effect will occur on the following trial. Likewise, increased connections improve task performance when a task is repeated but hinder task performance when the task changes, causing the modulation of the switch cost.

Although the hypothesis that conflict enhances associations is fairly recent, it has been long known that reward...
strengthens task-relevant associations. Thorndike’s (1911) Law of Effect stated that stimulus–response episodes are more likely to re-occur when followed by reward. Therefore, Skinner (1953) suggested that reward strengthens preceding or ongoing associations. In line with this half-century-old idea, two recent experiments demonstrated how reward increased both short- (Colzato, van Wouwe, & Hommel, 2007) and long-term (Waszak & Pholulamdeth, 2009) binding effects. By presenting positive pictures after correct responses, they demonstrated how rewarded stimulus–response associations can facilitate future task performance.

Since cognitive conflict and reward may act in a similar fashion, we decided to investigate the interactions between conflict-based and reward-based adaptations. We delivered performance-related reward in cognitive control tasks and hypothesized that conflict-based adaptations would be modulated by reward. Since we were planning to investigate the after-effects of reward signals, we expected that the effect of reward would depend on subjects’ reward sensitivity as measured by the BAS Reward Responsiveness Subscale questionnaire (Carver & White, 1994). This scale measures the impact of rewards on a subject’s feelings and motivations; for example, a typical question in this subscale is “When I get something I want, I feel excited and energized”.

2. Experiment 1

To test whether reward modulates the adaptation to conflict in congruency effects, we combined a four-choice color flanker experiment with reward signals in 25% of the trials. Participants did not receive reward when the response was too slow or incorrect. This way, reward signals were both randomly distributed and performance-related. A second group of subjects was assigned to a control condition in which the trials. Participants did not receive reward when the response was too slow or incorrect. This way, reward signals were both randomly distributed and performance-related. A second group of subjects was assigned to a control condition in which the trials and that these reward trials were randomly distributed and not cued. Participants also knew that a winner would be selected per group of ten subjects, in order to control for global reward expectations about the total number of subjects.

A fixation cross was presented, after which stimuli remained on the screen until the participant responded. The maximum response time (RT) was 1000 ms. On reward trials, the participant was given feedback in the form of “+1” presented centrally on the screen for 500 ms, unless he or she did not respond correct or within the maximum response time. In the latter case, or after a “no-reward” trial, a blank screen was presented for 500 ms. Participants knew that only when “+1” was presented, they scored an extra point. Finally, a blank screen was presented for 1000 ms. The between-subjects control condition was identical to the original experiment, except for the removal of the reward schedule, and the reward signal now being replaced by a meaningless stimulus (“@”).

2.1. Method

2.1.1. Participants

Forty-four students took part in return for credits or 6€ (range = 17–22 years, 35 female, 41 right-handed, 22 participants per condition).

2.1.2. Stimuli

Stimuli consisted of three squares: horizontally aligned, centrally presented and printed in one of the four possible colors (green, yellow, blue or red). Both flanks had either the same or a different color than the central square.

2.1.3. Procedure

The participants responded to the center square by pressing one of four horizontally aligned response buttons using their index and middle fingers. Subjects were randomly assigned to one of four response mappings, which were created by shifting the response mapping. Each block contained 48 trials. An equal number of congruent and incongruent trials were presented randomly: 25% of the trials were reward trials, which were randomized for the congruent and incongruent trials separately. After practice, participants performed 14 experimental blocks. Between blocks was a self-paced break in which the participants could see their updated score. Every ten participants, the subject with the best score received a store coupon worth 10€. All subjects were truthfully instructed about the reinforcement schedule; they were aware that rewards could only be gained on one out of four trials and that these reward trials were randomly distributed and not cued. Participants also knew that a winner would be selected per group of ten subjects, in order to control for global reward expectations about the total number of subjects.

A fixation cross was presented, after which stimuli remained on the screen until the participant responded. The maximum response time (RT) was 1000 ms. On reward trials, the participant was given feedback in the form of “+1” presented centrally on the screen for 500 ms, unless he or she did not respond correct or within the maximum response time. In the latter case, or after a “no-reward” trial, a blank screen was presented for 500 ms. Participants knew that only when “+1” was presented, they scored an extra point. Finally, a blank screen was presented for 1000 ms. The between-subjects control condition was identical to the original experiment, except for the removal of the reward schedule, and the reward signal now being replaced by a meaningless stimulus (“@”).

2.1.4. Questionnaires

Six months after the experiment, participants from the experimental condition were contacted with the request to fill in an online version of the Behavioral Inhibition System/Behavioral Activation System (BIS/BAS) Scales (Carver & White, 1994): 15 out of 22 participants responded to this request.

2.2. Results and discussion

In each feedback condition (reward and neutral “feedback”), a participant was excluded because accuracy was two standard deviations below the group average (group averages: $M = 0.90; SD = 0.07$ and $M = 0.85; SD = 0.10$). Trials following errors and the first trial of each block were removed. For RT analyses, errors were also excluded. From the remaining trials, RT outliers ($±2SD$) were removed (3.3%). We carried out an ANOVA with three within-subject factors (congruency, previous-congruency and previous-feedback) and the between-subjects factor feedback condition, on RTs and error rates. There was a significant congruency effect, $F(1,40) = 430.429, p < .001$, which interacted with previous-congruency, $F(1,40) = 18.027, p < .001$, indicating a significant conflict adaptation effect. A four-way interaction between feedback condition, previous-feedback, congruency and previous-congruency pointed at diverging effects of the different “feedback” stimuli, $F(1,40) = 4.713, p < .05$. In the reward condition, there was a conflict adaptation effect, $F(1,20) = 13.620, p < .01$, which interacted with previous-feedback, $F(1,20) = 4.953, p < .05$. As can be seen in...
Fig. 1a, the conflict-modulated congruency effect is larger after reward trials (subtracting the congruency effect after incongruent from the congruency effect after congruent trials: 28 ms), than after no-reward trials (4 ms). There was no main effect of previous-reward, nor an overall larger congruency effect after reward (both $F(1,20) < 1$). In the neutral condition, a significant conflict adaptation effect was observed, $F(1,20) = 6.016$, $p < .05$, which was not modulated by the irrelevant stimulus ($F(1,20) < 1$, Fig. 1b, 10 ms after “@” and 16 ms after blank screen). Error rates only revealed a significant congruency effect, $F(1,40) = 27.535$, $p < .001$.

As predicted, the differences in conflict adaptation effects (conflict-modulated congruency effect after reward

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**Fig. 1.** Response times for Experiment 1, reward feedback condition (a); and neutral feedback condition (b). The figure demonstrates how reward modulated the conflict-modulated congruency effect. Below, the scatter plot shows the correlation between individual scores on the BAS-Reward Responsiveness scale and the difference scores for the conflict-modulated congruency effects (c). The error bars are ±1 standard error.
minus after no-reward) correlated with the BAS-Reward-Responsiveness subscale \((r = .553, p < .05, \text{Spearman's } \rho = .460, p = .090, \text{Fig. 1c})\). Moreover, the differences in these effects correlated with the other BAS subscales (BAS-Drive, \(r = .490, p = .075, \rho = .499, p = .069\); BAS-Fun-Seeking, \(r = .541, p < .05, \rho = .482, p = .081\)). No correlations were observed with the BIS-scale \((\forall p > .1)\).

To rule out the effects of feature repetition and/or integration effects (e.g., Hommel, Proctor, & Vu, 2004) in explaining the reward modulation of adaptations to \(\text{Seeking}, \rho = .553, p < .05, \text{see Notebaert & Verguts, 2007}\). To account for between-subjects variance, a multiple regression analysis is performed for each participant separately. Subsequently, the average of each coefficient across participants is tested with a one-sample \(t\) test \((\text{Lorch & Myers, 1990})\). In this way, we can test if our crucial interaction between previous reward, previous congruency, and congruency \((\text{in the reward condition})\), remains after controlling for feature repetition and/or integration effects. Along with our previously reported variables of interest, we added five binary \((0 \text{ or } 1)\) bottom-up factors (see Notebaert & Verguts, 2007), to our multiple regression analysis with reaction time as the dependent variable. The first factor was the repetition of the target, and the second repetition of the flanker. The third factor, called feature integration, codes for complete repetitions and alternations \((1)\) versus partial repetitions \((0)\). The last two factors were respectively negative priming \((\text{distractor – becomes–target repetition})\) and target – becomes-distractor repetition. On top of those factors, we also chose to control for the interactions between previous reward and each of those factors. The analyses show that our main interaction of interest, between previous reward, previous congruency and congruency, can still be observed, \(t(20) = 1.874, p = .076\). This, after controlling for all the effects of feature repetition and their interaction with previous reward. The main effects of feature integration, target repetition, flanker repetition, and negative priming, all reached significance \((\forall p < .05)\). Additionally, there was a significant interaction between target repetition and previous reward, \(t(20) = 3.564, p < .05, \text{indicating a stronger target repetition effect, when the previous trial was rewarded} \) (see also Hickey, Chelazzi, & Theeuwes, 2010a).

These results demonstrate how the conflict adaptation effect is modulated by reward. This modulation of the congruency effect after reward seems to be primarily driven by a modulation of the congruent trials (cf. Akçay & Hazeltine, 2007; Fernandez-Duque & Knight, 2008; Ullsperger, Bylisma, & Botvinick, 2005). Compared to after incongruent no-reward trials, congruent trials are processed slower after incongruent rewarded trials, \(t(20) = 2.3, p < .05\), suggesting a more cautious response strategy after conflict. Similarly, congruent trials are processed faster after congruent rewarded trials, compared to after congruent no-reward trials, \(t(20) = 3.0, p < .01\). In explaining this pattern of the conflict adaptation effect, where conflict trials do not seem to modulate subsequent conflict trials, Schlaghecken and Martini (2012) recently stressed the importance of context, rather than conflict. The authors suggest that both congruent and incongruent trials modulate behavior and thereby nuance current theories of cognitive control that focus on the role of incongruent \((\text{conflicting})\) trials. Nevertheless, the relative cost of incongruent trials \((\text{as compared to congruent trials})\) was significantly reduced after conflict, indicating increased task focus. Importantly, if the enhancement of the conflict adaptation effect after reward is indeed the result of increased task focus, we can expect a similar modulation of the conflict-modulated task switch cost.

3. Experiment 2

Here, we tested whether reward modulates the adaptation to conflict in task-switch costs. We used a task-switching design with an arrow flanker task and a Simon task \((\text{Simon, 1969})\), with reward signals. The Simon effect is the observation that responses are faster when stimulus and response locations correspond, despite the stimulus location being irrelevant \((\text{Simon, 1969})\). Contrary to the original bivalent-stimulus designs by Goschke (2000) and Brown et al. (2007), where conflict results from cross-task interference, we used two independent conflict tasks where conflict originates from competing responses within a task. To our knowledge, a conflict-modulated task switch cost has not been demonstrated in such a design, but it is predicted by cognitive control theories \((\text{Verguts & Notebaert, 2009})\). Our control condition, without reward manipulation, can therefore be considered as a test of this prediction.

3.1. Method

3.1.1. Participants

Forty-four students took part in exchange for credits \((\text{range } = 17–22 \text{ years, } 42 \text{ female, } 37 \text{ right-handed, 20 per condition})\).

3.1.2. Stimuli

For the Simon task the stimuli consisted of the character ‘X’ in blue or red, presented on the left or right side of the screen. In the flanker task, the stimuli were centrally presented arrows pointing left or right, flanked by congruent or incongruent arrows on each side.

3.1.3. Procedure

Participants performed a flanker or Simon task, depending on the presented stimulus. In the flanker task, participants pressed right \((\text{left})\) when the middle arrow pointed to the right \((\text{left})\). In the Simon task, subjects pressed right \((\text{left})\) when the letter ‘X’ was blue \((\text{red})\). The assignment of stimulus color to response was counterbalanced across participants. 25% of the trials were reward trials, randomized for tasks and congruency conditions separately. The same reward schedule, block/trial procedure, apparatus and control condition were used as in Experiment 1. The maximum RT was set to 750 ms.

3.1.4. Questionnaires

All 22 participants from the reward condition filled in the BIS/BAS-Scales, immediately after the experiment.
3.2. Results and discussion

In each condition (reward and neutral feedback), one participant was excluded because of an accuracy two standard deviations below the group mean (group averages: $M = 0.90$; $SD = 0.05$ and $M = 0.88$; $SD = 0.11$). Trials following an error and the first trial of each block were removed. For the RT analyses, errors were also excluded. From the remaining trials, RT outliers ($\pm 2SD$) were removed (3.7%).

We carried out an ANOVA with three within-subject factors (task sequence, previous-congruency and previous-feedback) and the between-subjects factor feedback condition on RTs and error rates.

There was a significant task-switch cost, $F(1,40) = 342.393$, $p < .001$, which interacted with previous-congruency, $F(1,40) = 7.575$, $p < .01$, indicating a significant conflict-modulated task switch cost. A four-way interaction between feedback condition, task sequence, previous-congruency, and previous-feedback hinted at different effects of the “feedback” stimuli, $F(1,40) = 3.000$, $p = .09$. Crucially, in the experimental condition, there was a significant three-way interaction between task sequence, previous-congruency, and previous-feedback, $F(1,20) = 5.704$, $p < .05$. As can be seen in Fig. 2a, the modulation of the task switch cost is only observed after reward trials, $F(1,20) = 4.819$, $p < .05$ (subtracting the task-switch cost after congruent from the task-switch cost after incongruent trials: 12 ms), but not after no-reward trials ($-2 ms$). There was neither a main effect of previous-reward, nor a task-switch cost by previous-reward interaction (both $p > .1$). Similar to Experiment 1, there was only a conflict-modulated task switch cost after reward. In the control condition, a significant modulation of the task switch cost was observed, $F(1,20) = 4.630$, $p < .05$, which was not modulated by the irrelevant stimulus presentation ($F(1,20) < 1$, Fig. 2b, 8 ms after “@” and 8 ms after blank screen).

Error rates only showed a significant task-switch cost $F(1,40) = 53.526$, $p < .001$.

As predicted, the questionnaires revealed a positive correlation between the difference in the conflict-modulated task switch cost (modulation of the task switch cost after reward minus after no-reward) and the BAS-Reward-Responsiveness subscale ($r = .617$, $p < .005$, Spearman’s $\rho = .581$, $p < .01$, Fig. 2c). The difference in the task switch cost modulations did not correlate with other scales (all $p > .1$).

As in Experiment 1, to rule out the effects of stimulus or response repetitions (e.g., Hommel et al., 2004), we reanalyzed our data from the reward condition by means of multiple regression analysis with reaction time as the dependent variable: The first factor was target repetition, and the second factor response repetition. Moreover, we also controlled for the interactions between previous reward and each of those factors. Similar to Experiment 1, the analyses show that our main interaction of interest (task sequence, previous-congruency, and previous-feedback) can still be observed, $t(20) = 2.366$, $p < .05$, after controlling for the significant main effects of target repetition and response repetition (both $p < .001$).

4. General discussion

The experiments demonstrated how cognitive adaptations after incongruent trials can be modulated by reward. More specifically, reward feedback modulated conflict adaptation (measured by congruency effect and task-switch cost in Experiments 1 and 2, respectively), and these reward modulations were subject to individual differences in reward responsiveness, as measured by the BAS-Reward-Responsiveness subscale.

The current study extends earlier findings suggesting that rewarding events reinforce binding (Colzato et al., 2007; Waszak & Pholulamdeth, 2009), but also a more generally growing literature pointing to the influential role of reward in cognitive control. For instance, by rewarding two colors in a four-choice Stroop task, Krebs, Boehler, and Woldorff (2010) observed that reward strengthens specific stimulus–response bindings, thereby reducing the congruency effect for rewarded stimuli only. Similarly, these results add to the findings of Stürmer, Nigbur, Schacht, and Sommer (2011) which showed an enhanced conflict adaptation effect in a Simon task after reward, when rewarding the top fastest responses. On a perceptual level, Hickey et al. (2010a) demonstrated how processing reward-associated visual features was facilitated, even when resulting in suboptimal performance. Furthermore, they demonstrated how these effects of reward are limited to task-relevant target selection, but not distractor suppression (Hickey, Chelazzi, & Theeuwes, 2011). Interestingly, the latter two studies also demonstrated how reward acts as a context changer. In their studies, normally observed priming effects were only observed after high reward, not after low reward. Similarly, we only observed conflict adaptation after reward. These results demonstrate that no-reward trials are not just a neutral and constant baseline. Instead, by introducing reward signals, we gave both reward and no-reward trials an informative value. Possibly, the absence of reward may have devaluated the learning value of the conflict signal. Cognitive conflict has been conceptualized as a learning signal (Botvinick, 2007; Verguts & Notebaert, 2009) that motivates people in adapting their performance on subsequent trials. Therefore, it can be argued that people devaluate this learning signal, when it remains unrewarded (in a reward context). Consequently, since responding to the previous conflict trial was not fruitful, people feel no need adapting to it. This stresses the motivational significance of a conflict trial (or correctly responding to it; see below) in a non-reward environment, where adaptations to conflict can be observed. Alternatively, our results could also be interpreted in terms of punishment in that participants could feel punished after no-reward trials. However, since participants were truthfully informed on the reward schedule and knew to expect no-reward trials on 75% of the trials, we believe that they did not perceive no-reward trials as punishing. Furthermore, our correlation with BAS Reward Responsiveness
(and no correlation with BIS) suggests that a reward, rather than punishment, modulation explains our current effects.

The individual differences in BAS Reward Responsiveness predicted the modulations of reward on adaptations to conflict in both experiments. This is consistent with earlier reports demonstrating the important role of BAS Reward Responsiveness (Boksem, Tops, Wester, Meijman, & Lorist, 2006; De Pascalis, Varriale, & D’Antuono, 2010).
and BAS overall (Amodio, Master, Yee, & Taylor, 2008), in explaining individual differences in cognitive control. However, it must be noted that earlier studies looking at the after-effects of reward signals in cognitive control often also found correlations with BAS Drive, rather than BAS Reward Responsiveness (Hickey, Chelazzi, & Theeuwes, 2010b; van Steenbergen, Band, & Hommel, 2009). Similarly, our modulation in Experiment 1, but not Experiment 2, correlated with BAS Drive. Yet, it has been suggested, that BAS Drive and BAS Reward Responsiveness may as well tap a similar construct (Franken & Muris, 2006; Zelenski & Larsen, 1999), both measuring reward sensitivity. Hence, differential modulation of the BAS Drive and BAS Reward Responsiveness subscales has to be treated with caution.

We believe that our findings can be parsimoniously explained by associative models of cognitive control. Literature suggests that reward signals modulate binding processes and the theoretical framework of Verguts and Notebaert (2008, 2009) describes how adaptations after conflict can be understood in terms of adaptation by binding. Therefore, we reasoned that, by strengthening task-relevant associations, rewards should modulate the effects of cognitive conflicts. We demonstrated this in two different adaptations to conflict. Importantly, to our knowledge, our conflict-modulated task-switch cost (Goschke, 2000) is the first one observed in a task-switching study with two independent conflict tasks (Experiment 2), as predicted by the model of Verguts and Notebaert (2009). Additionally, Verguts and Notebaert (2009) also suggested that the strengthening of associations after conflict is mainly triggered by conflict-induced arousal. This idea, that arousal helps strengthening associations, is consistent with our finding that people who feel more energized or aroused after reward (as measured by BAS Reward Responsiveness) show a greater modulation of their adaptation to conflict.

Alternatively, the feature integration account (Hommel et al., 2004) explains these sequential effects in terms of stimulus–response repetitions. In this view, the observed modulation of these sequential effects by reward could be due to the enhancement of stimulus–response associations by reward. The adaptation-by-binding account (Verguts & Notebaert, 2009) relates to this theoretical framework, in that both use binding to explain these cognitive adaptations. However, the adaptation-by-binding model holds that conflict enhances all active task-relevant associations (including, but not only, repeating stimulus–response associations). Therefore, by means of multiple regression (Notebaert & Verguts, 2007), we demonstrated how reward modulations of adaptations to conflict can still be observed after controlling for feature integration effects and their interactions with reward (see Results). This indicates that the effect of reward goes beyond strengthening stimulus–response associations and reflects the modulation of conflict-based adaptations.

The influential conflict monitoring theory of Botvinick, Braver, Barch, Carter, and Cohen (2001) explains these adaptations to conflict by enhanced task attention after conflict. This model implements cognitive control on a different level than the adaptation-by-binding account (see Braem, Verguts, & Notebaert, 2011). Yet, the conflict monitoring theory could also explain our main findings, albeit with the additional assumption that reward enhances top-down attention (e.g., Della Libera & Chelazzi, 2006; Locke & Braver, 2008). However, it is important to note that the conflict monitoring theory has led to opposite predictions as well. van Steenbergen et al. (2009) hypothesized, on the basis of conflict monitoring, that people relax their control system when receiving reward. The authors suggested that, if the aversive quality of conflict (Botvinick, 2007) signals the need for adjustment, it should be possible to counteract control operations when presenting positive reward signals. This was tested by combining a standard flanker task with punishment and reward signals, similar to our Experiment 1. Interestingly, van Steenbergen et al. (2009) observed a conflict-modulated congruency effect in a flanker task after neutral and punishment trials (neutral and sad faces, respectively), but not after rewarded trials (happy face). However, rewards were not contingent on the response accuracy, whereas in our study, reward signals only followed correct responses and participants were explicitly informed about this. Therefore, van Steenbergen et al. may have observed the modulating effects of the more affective effects of reward, as induced by the faces, rather than the motivational effects of reward. This would be in line with the results of Dreisbach and Goschke (2004), who found increased distractibility following positive affect inducing pictures independent of response accuracy. We believe that the modulation of this conflict adaptation effect by short-term (van Steenbergen et al., 2009) or long-term (van Steenbergen, Band, & Hommel, 2010) affect inductions should be distinguished from the motivational aspect of reward. This relates to the neurobiological theory of Berridge and Robinson (2003), conceptualizing the different motivational, learning, and affective components of reward. In their view, our results could be a manifestation of the motivational and learning effects of reward, whereas the study of van Steenbergen et al. (2009) demonstrated effects of the affective component of reward. The need for a differentiation between these effects of motivation and positive valence was also recently stressed in a review by Chiew and Braver (2011) and calls for further research.

When focusing on the affective value of reward, it might seem surprising that reward enhances the cognitive adjustments triggered by conflict. Cognitive conflict has been suggested to be aversive (Botvinick, 2007; Dreisbach & Fischer, 2012) or at best arousing (Verguts & Notebaert, 2009). However, when focusing on the motivational aspect, successfully responding to a more difficult task can be associated with increased intrinsic reinforcement signals (Satterthwaite et al., 2012). Hence, participants can find it more motivationally significant to complete an incongruent trial than a congruent trial. In this way, while conflict may be experienced as negative (Dreisbach & Fischer, 2012), conflict resolution can be perceived as positive. Consistently, a recent computational model demonstrates how correctly responding to incongruent trials can generate larger positive prediction errors (as compared to congruent trials) in anterior cingulate cortex (Silvetti, Seurinck, & Verguts, 2011).
Carrying this reasoning one step further, this motivating aspect of conflict resolution, rather than conflict itself, may be what steers typically observed cognitive adaptations. This intrinsic reward would then be what motivates a person to enhance the task-relevant associations that drove him/her to that response. In line with this, patients with Parkinson’s disease, who exhibit a reduced sensitivity to reward (Frank, Seeberger, & O’Reilly, 2004), typically do not show a conflict adaptation effect (e.g., Fielding, Georgiou-Karistianis, Bradshaw, Millist, & White, 2005; Praamstra & Flat, 2001). Possibly, patients with Parkinson’s disease are not susceptible to the motivating aspect of incongruent trials. In fact, this idea also fits our data: incongruent trials reduced the congruency effect (Experiment 1) and enhanced the task-switch cost (Experiment 2) only after reward. In our experiment, the external reward may have superseded the intrinsic reward signal, so that people no longer learn from conflict, in the absence of their hoped-for reward.

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