Effects of Conflict Strength in the Flanker Task: An ERP Study

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Lay Summary

The experience of response conflict has several effects on people's behaviour. When conflict is high, participants react slower and commit more errors. Interestingly, after the experience of conflict, the level of cognitive control is increased, resulting in much more conservative behaviour. In this study we have manipulated the conflict strength in a flanker task, a task that is known to produce conflict, by manipulating the visibility of the stimulus letters. Participants responded slower when visibility of the relevant letter was low. Events with conflicting information (relevant letter surrounded by different letters) were more difficult, leading to slower reactions. We also found evidence for increases in cognitive control after conflict. The extent of this increase was influenced by the visibility of the stimulus letters.

Electrical brain activity linked to conflict processing (N2 component) was identified. The amplitude of this component, however, did not fully correlate with the behavioural results, challenging current theories of cognitive control.

Introduction

According to the Conflict-Monitoring Theory (Botvinick et al., 2001), people monitor for the occurrence of conflict in information processing in order to evaluate the need for cognitive control. Conflict is defined as the simultaneous activation of incompatible response tendencies. The amount of conflict increases with (1) the **absolute activation** of competing representations; (2) the **number** of competing representations; and (3) it is maximal when all representations are **equally activated** (Berlyne, 1957).

In the current study we manipulated conflict by independently varying the contrast of target and distractor letters in the Eriksen flanker task (Eriksen & Eriksen, 1974). The Conflict-Monitoring Theory predicts that (1) conflict is higher when all letters have high rather than low contrast (absolute activation); (2) conflict is higher when the distractors have higher contrast than the target as compared to when the distractors have lower contrast than the target (relative activation). The theory also predicts that (3) subsequent control adjustment should be larger when conflict is high.

Method

Participants

24 volunteers between 18 and 31 years of age (M = 21.5), 14 women

Task

Adaptation of the Eriksen flanker task:

Responding to the central letter of a 5-letter-array by pressing one of two response keys, each of which is associated with one response hand.

Compatible Stimuli	HHHHH	SSSSS
Incompatible Stimuli	HHSHH	SSHSS

One response key is associated with the H the other one with the S. Therefore, incompatible stimuli generate conflict, whereas compatible stimuli do not.

Participants were instructed to respond as fast as possible while maintaining an error rate of about 10%.

Four Contrast Conditions:

HHSHH	Dark flankers, dark target (darkF-darkT)
HHSHH	Light flankers, dark target (lightF-darkT)
HHSHH	Dark flankers, light target (darkF-lightT)
HHSHH	Light flankers, light target (lightF-lightT)

All stimuli were presented on white background.

Recording

BIOSEMI system, 72 Ag/AgCl electrodes, sampling rate 256 Hz

Behavioural Results

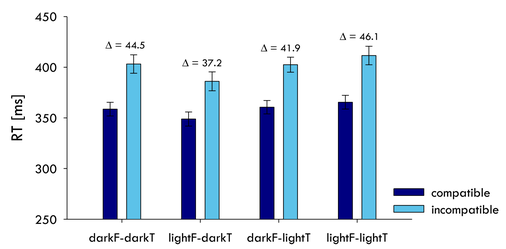
Error Rate

Participants made about 4% errors on compatible trials and 15% errors on incompatible trials ($F(1, 23) = 205.4$, $p < .001$). There were no significant differences between contrast conditions ($F(3, 69) < 1$).

Reaction Times

Effects of Conflict

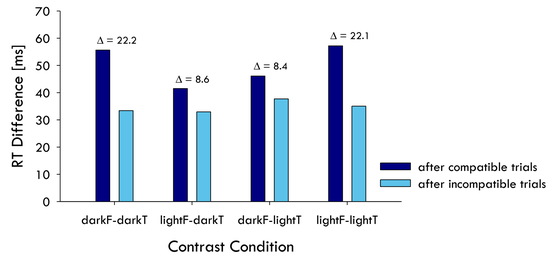
Compatibility Effect



- Participants are faster on compatible (358ms) than on incompatible trials (401ms); $F(1, 23) = 169.7$, $p < .001$
- Participants respond faster to dark targets (374ms) than to light targets (385ms); $F(1, 23) = 10.8$, $p < .01$
- Reaction times do not differ significantly between dark and light flankers (381ms and 378ms, respectively; $F(1, 23) = 0.7$)
- The difference between dark and light targets is larger when the flankers are light; $F(1, 23) = 16.9$, $p < .001$
- Neither target contrast nor flanker contrast have differential effects on the compatibility effect ($F(1, 23) = 1.8$ and $F(1, 23) = 0.4$, respectively)

Control Adjustment Effects

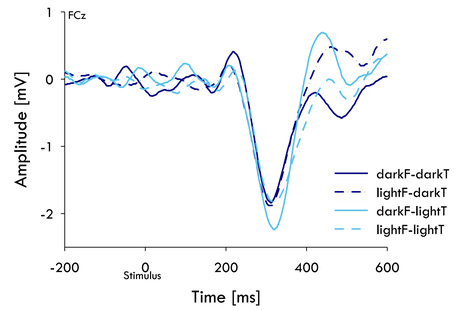
Gratton Effect:
Difference Between Incompatible and Compatible Trials



- The reaction time difference between compatible and incompatible trials is smaller when the previous trial has been incompatible (35ms) than when it has been compatible (50ms); $F(1, 23) = 35.4$, $p < .001$ → Gratton Effect
- The Gratton Effect is not significantly influenced by either target contrast or flanker contrast (both $F(1, 23) < 0.1$)
- A significant four-way interaction of current trial compatibility, previous trial compatibility, target contrast and flanker contrast is due to a reduction of the Gratton Effect in the conditions with mixed contrast (lightF-darkT and darkF-lightT); $F(1, 23) = 16.5$, $p < .001$

Electrophysiological Results

N2 Difference Wave (incompatible - compatible)



- Neither target contrast nor flanker contrast have a significant influence on N2 amplitude; (both $F(1, 23) < 1$)

Conclusion

The results show the usual increase in reaction time for stimuli with conflicting information (incompatible stimuli). The significant main effect of target contrast confirms that the manipulation was effective; participants responded faster to high than to low contrast targets. However, the compatibility effect was not influenced by either target or flanker contrast. This contradicts the Conflict-Monitoring Theory, which predicts an increased compatibility effect in the darkF-lightT condition and a reduced effect in the lightF-darkT condition. This argument is supported by the electrophysiological data. The amplitude of the N2, an ERP component which has previously been associated with conflict processing (Yeung, Botvinick & Cohen, 2004), is not influenced by the contrast manipulation.

The previously described reduction of the compatibility effect following an incompatible trial as compared to following a compatible trial (Gratton Effect; Gratton, Coles and Donchin, 1992) has been confirmed in this study. This effect can be interpreted as an increase in cognitive control after experiencing conflict. Therefore, the adjustment should be larger the higher the conflict on the previous trial was. In the current experiment the adjustment was largest in both conditions with mixed contrast, which again challenges the Conflict-Monitoring Theory.

References

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