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Conflict-Monitoring and Reaction Time Distributions: an Extension

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Introduction

In conflict tasks, such as the Eriksen flanker task, a response to a target stimulus is interfered with by the presence of task-irrelevant information that is associated with a different, competing, response. For example, when the middle character is the target, a left button press is faster when the stimulus is congruent (e.g., <<<) than when it is incongruent (e.g., ><>). The flanker task has been used extensively in the cognitive and neuroimaging literature investigating the nature of cognitive control. Here, I focus on one theory emanating from this cross-disciplinary literature that has been explicated in a computational model.

The conflict-monitoring hypothesis by Botvinick et al (2001) states that conflict is monitored on trial n. This conflict could be monitored at different levels of processing, with the response level being investigated the most. This conflict is used to adjust the level of cognitive control on trial n + 1. Although there are a number of empirical findings that can be captured by the conflict-monitoring hypothesis, there are few that the model can not address, such as the time-course of the RT-interference effect as a function of response speed. Here I will show how a simple extension (Davelaar, submitted) to the original model helps in capturing these data.

The Deltaplot

Although mean reaction time (RT) is typically used as the main dependent measure, several studies have highlighted the benefits of analyzing the RT distributions. In one such analysis, the RT-interference effect is plotted as a function of response speed. This so-called deltaplot forms a graphical display of the comparison between the RT-distributions of the incongruent and congruent trials. The typical finding is a negatively accelerated function.

Within-Trial Conflict-Adaptation

The model is similar to the type of models presented by Botvinick and colleagues. The only critical difference is that conflict that is monitored at the response level is passed through a sigmoidal function (to maintain a value between 0 and 1) and used to modulate the external input *within the same trial*. The result of this extension is that during a trial the amount of the conflict increases and at a certain level of conflict the system starts to exert cognitive control. This threshold-like feature is due to the use of a sigmoidal function that has a slope, g, and a threshold, d. The trials that are mostly affected are the ones that produce the most

the conflict, i.e., the incongruent conditions. In other words cognitive control is only exerted when the trial demands it.

The original Botvinick models are unable to capture this finding due to the fact that monitored conflict is not used within the same trial, but for the subsequent trial. However, both within- and across-trial use of conflict could be captured by using a variable decay parameter (not modeled).
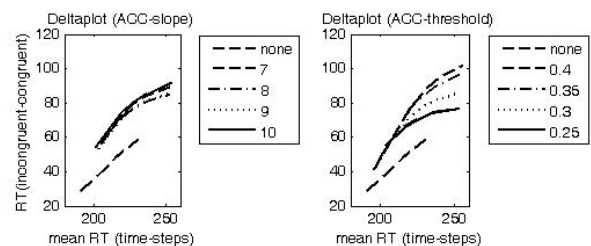

Figure 1: Results of a flanker model with left and right pointing arrows. Deltaplots are constructed which show the RT-interference effect ($RT_{incongruent} - RT_{congruent}$) as a function of response speed. The figure on the left shows how the deltaplot is affected by the slope of the sigmoidal function. Note that not much difference exists between different slope values, but that all values produce a classical RT-profile. The dashed line represents the situation in which the monitored conflict is not used to adjust cognitive control. This condition produced the poorest performance (0.2% accuracy). The figure on the right shows how the deltaplot is affected by the threshold of the sigmoidal function. The lower the threshold, the earlier and the stronger the bent in the deltaplot is. Decreasing the threshold makes the system sensitive to conflict.

Reflections

Using within-trial conflict adaptation, the model not only captures the shape of the deltaplots, but it also allows for addressing neuroimaging findings (see Davelaar, submitted). The current work underscores the need to take detailed RT-distributions into account when developing models of cognitive control.

References

Botvinick, M. M., Braver, T. S., Carter, C. S., Barch, D. M., Cohen, J. D. (2001). Evaluating the demand for control: anterior cingulate cortex and crosstalk monitoring. Psychological Review, 108, 624-652.

Davelaar, E. J. (submitted). A computational study of conflict-monitoring at two levels of processing: reaction time distributional analyses and hemodynamic responses.