Back in control : the episodic retrieval of executive control

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CHAPTER 7: SYNOPSIS AND DISCUSSION

The question of how we are able to exercise voluntary action, or 'free will', in the face of automaticity, distraction and temptation, has long been debated. From an empirical point of view, the solution may be found by investigating simple psychological effects that show a robust behavioural effect of being distracted and understanding how and when participants are, in fact, *not*. Gratton, Coles & Donchin (1994) for example, showed that after people are tempted to react to the flankers of a visual stimulus, they tend to perform better if the incongruous stimulus is presented again. Likewise, in Stroop (1935) and Simon (Simon & Rudell, 1967) effects, repeating stimulus-response conflict typically leads to better performance (Kerns et al., Stürmer et al.). The influential conflict-monitoring model in neuroscience attempts to solve the problem by having a brain structure scan for response-conflict and, upon detection, change decision-making strategies to avoid repetition of such aversive conflict (Botvinick, 2007). Thus, the conflict-adaptation (or Gratton-) effect concerns the relative enhanced performance of conflict-conflict sequences to non-conflict-conflict sequences.

Despite the model's parsimony and effective prediction of many sequential conflict results, it is not without challenges. In marked contrast to conflict-adaptation, social psychologists found that after exerting self-control, resources for repeated self-control are typically *lower* (Baumeister, Vohs & Tice, 2007). Moreover, one may wonder how people are able to resist the temptation of acting upon distracters in the absence of previous, adaptation-incurring conflict. Logan (1980; 1988), for instance, would argue that the many instances in which we learned to read words, rather than naming their colours, are retrieved upon completing a Stroop-test, and interfere with the goal of naming the colours.

In this dissertation, the hypothesis is explored that memory – episodic retrieval – is a necessary condition for conflict-adaptation to occur. The radical variation of this hypothesis states that the repetition of the features constituting

conflict, rather than the attentional mechanism which supposedly 'solves' the conflict, account for all the variation in sequential modulation studies, therefore not requiring 'conflict-monitoring'. The less radical variation of the hypothesis involves the mostly unexplored option that episodic retrieval is required for conflict-adaptation to occur. After experiencing conflict in one task, this option states that the conflict-control that is required to defeat the temptation (for example: 'narrow your attention' after seeing conflicting flankers) is integrated in the episodic trace. If a subsequent event then reminds of the previous event, such control-parameters are retrieved and may help controlling current conflict.

Of course, most models based on conflict-monitoring are implicitly or explicitly reliant on memory or working memory, yet their accounts more indirectly link memory to cognitive control. For one, in the original Botvinick et al. (1999) model, detecting conflict leads to enhanced activation of working memory, so that subsequent stimulus-response incompatibility can be better dealt with. In Stürmer et al.'s (2002) dual route model, after a mismatching Simon trial, the automatic stimulus-response route will be suppressed if it is detected as being disadvantageous. Presumably, in order to inhibit this route in such a way that it affects the processing of the subsequent trial, working memory is required. Finally, in a recent review by Verguts & Notebaert (2009), a noteworthy attempt is made to bridge the gap between binding and conflict-monitoring, by suggesting that detection of conflict leads to arousal, which in turn facilitates binding.

These accounts differ from the hypothesis in this dissertation on two grounds. Firstly, binding is approached mainly from a retrieval perspective, as suggested by Hommel (1998), rather than as a forward process such as priming (Bertelson, 1963; Meyer & Schvaneveldt, 1971; Mayr et al. 2003) in which alternations of stimuli or responses are detrimental to performance. One may see binding as similar to these processes: on a given trial, stimulus and response features are temporarily associated with one another, such that stimulus A is

associated with response 1 into A1. This binding may be kept activated, for example in working memory. If a later stimulus-response episode requires either A or 1 for a new binding, a problem occurs because they are already bound to the previous stimulus. Although some authors (e.g. Notebaert, Gevers, Verbruggen & Liefooghe, 2006) are not exactly clear whether they interpret the binding process like this, it should be stressed that the account put forward here does not. Instead, my line of reasoning is based on the logic underlying Kahneman, Treisman & Gibbs' (1992) *reviewing* effects (c.f. chapter 3) and Hommel's (2004) event file retrieval. An encounter with episode A2 will *retrieve* episode A1 merely due to the overlapping feature A. If the retrieval reactivates stimulus and/or response features that conflict with features of the current stimulus and/or response, performance is hampered. This more or less passive retrieval process entails that there is no active maintenance of a binding per se.

Secondly, the claim here is that cognitive control *depends* on such retrieval processes. Either because all sequential modulation effects boil down to episodic retrieval – the radical approach – or because episodic traces also contain information regarding executive control – the less-radical approach – the claim is made that without episodic retrieval, there is no control. Thus, unlike in the *pro-active* conflict monitoring accounts, even if some allow a role for feature integration, the hypothesis is that cognitive control is possible *if and only if* episodic retrieval allows it to be.

Chapters 2 and 3 illustrate the basic mechanism of episodic retrieval without reference to conflict. In Chapter 2, the basic sequential paradigm, or typical Event Coding task, is explained. Perceiving and acting upon a set of features are assumed to result in a representation combining these as single "Event file", such that encountering one of the features again brings back the whole former event, which in turn may help (if every other feature is also repeated) or hinder (if other features are alternated, resulting in 'partial-repetition costs') subsequent

performance (Hommel, 1998; Zmigrod, Spapé & Hommel, in press). Importantly, partial-repetition costs were found to be related to retrieval, rather than encoding, as the cue that indicated the relevance was shown only in the second part of the task. Chapter 3 uses a similar task, but shows that event-files can be adapted if their features gradually change over time. However, it is also shown that the history of its previous location is not wiped out, or flushed, but is stored separately, as part of the same event-file.

With that information at hand, Chapters 4, 5 and 6 went back to the issue of voluntary action, adding feature-integration related manipulations to disentangle priming, feature-integration and conflict-monitoring sources of variance from the conflict-adaptation effect. In an attempt to find out how imitation mechanisms work, Chapter 4 described an experiment in which participants were asked to ignore distracting voices and instead respond to high or low tones. Though finding no effect whatsoever of being required to imitate ones' own voice, changes in voices, although entirely irrelevant to the task, were found to strongly affect the conflict-adaptation effect. This result prompted the less radical hypothesis regarding conflict-adaptation: control-related parameters (such as 'ignore the voice') might have been encoded into episodic traces or instances (i.e. 'ignore *this* voice'), such that after hearing the same voice, the parameters were retrieved, helping to resolve current conflict and resulting in a fully fledged conflict-adaptation, but not after hearing a different voice.

Chapter 5 used the manipulation of Chapter 3 to adapt a Simon effect *feature-integration style*: after rotating a stimulus-display (say, a stimulus left that was responded to with a right key-press) for 180 degrees, results closely mimicking those of Chapter 3 were obtained. Analysing both partial-repetition costs and conflict-adaptation, both were near-zero after rotation, thus supporting both radical and less radical position. For the radical position, the answer would be simple: indeed, the results look so similar to the non-conflict effects of Chapter 3

because feature-integration is enough to account for the conflict adaptation. Alternatively, the rotation might have rotated the response along with the stimulus and control-related effects continued playing a part, though not quite as obviously. Chapter 6, apart from showing robust, psychophysiological correlates to these effects, favours the radical position, as all effects were found to be incurred by presenting the second part of the task (S2), instead of affecting S1-locked LRP.

Yet, the difference between the radical (all conflict-adaptation *is* feature-integration) and less radical (conflict-adaptation depends on feature-integration) hypothesis may not be so great as is often assumed. If we leave the whole sequential effects aside, for example, why are people distracted by the word, if required to name the colour? What is the nature of the temptation? In essence, we assume that the features of the world retrieve their lexical, semantic and production features, and it is likely that due to our learning history, this retrieval is faster and more automatic than executing the task-set goals in psychological experiments (cf. Logan, 1988). Similarly, in Simon effects, not the location itself produces the conflict, but its partial repetition with our goal to respond in locations (Hommel, 1993). Episodic retrieval should therefore not be seen as an annoying, confounding variable in 'executive control' type of experiments, but as both the reason why distraction exists in the first place and how it can ultimately be overcome.