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Motivated executive attention—incentives and the noise-compatibility effect

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Abstract

The motivational context is an important variable in experimental research. The present study investigates the effects of reward and punishment on performance in a noise-compatibility-task [Eriksen, B.A., Eriksen, C.W., 1974. Effects of noise letters upon the identification of a target letter in a nonsearch task. Perception and Psychophysics 16 (1), 143–149]. Flanking distractors indicated a response, which was identical, undefined, or opposite to the appropriate response indicated by the central target. At the beginning of each trial a cue specified positive, negative or no reinforcement in order to elicit three different motivational states: approach, avoidance and a non-reinforced neutral state. Fifty-three subjects (aged 20–27 years) participated. Incompatibility effects on reaction times and percentage errors were analysed as a function of motivational state, as were the effects on two ERPs, the lateralised readines potential (LRP) and the N2. Error and LRP data showed effects of reinforcement only when incompatible distractors were present, which indicates that controlled processing depends on the motivational context. In contrast to previous findings, the N2 was not found to depend on response conflict.

Keywords: Noise-compatibility-task; Eriksen–Flanker-task; Monetary incentive; Motivation; Motived attention; LRP; N2

1. Introduction

Several years ago Peter Lang emphasized that "attention is determined by primarily motivation" (Lang et al., 1997, p. 97). Recent research has shown increasing interest in the conjoint observation of attentional and motivational processes (e.g. Bradley et al., 2003; Derryberry and Tucker, 1994).

The present study will investigate the relation between motivation and attention in a noise-compatibility-task, which was invented by Eriksen and Eriksen (1974) (see also Eriksen, 1995 for a more detailed overview) and is also known as Eriksen- or Flanker-task. To provide the relevant background to this task, we will first introduce the paradigm and the theoretical concepts that explain the observable effects. Afterwards we discuss a possible relation between different systems of motivation and processes of attention (in the noise-compatibility-task) based on theoretical approaches and empirical data. Finally, the rationale for the design of the current experiment will be given.

1.1. The noise-compatibility-task and its theoretical background

Contemporary attention research distinguishes between *executive/controlled* and *automatic* processes (Norman and Shallice, 1986; Posner and DiGirolamo, 1998). Automatic processes are quite rapid, parallel and lead to fast response times, but they are also error-prone, especially when dealing with difficult tasks. The crucial automatic process involved in the noise-compatibility-task is described in the continuous flow model by Eriksen and Schultz (1979). They proposed that fragmented information about a stimulus is immediately transmitted from the perceptual systems to the

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response systems as soon as the analyses have begun. Response preparation starts unintentionally when the first information fragments arrive. If those fragments carry conflicting information about the response they compete with each other for response capacities. The resulting interference makes the selection of the correct response more difficult.

In order to resolve those conflicts controlled processes are necessary (Casey et al., 2000; Gratton et al., 1992; Kopp et al., 1996; Iwaki et al., 2003). Controlled processes are described as flexible and adaptive, but also as rather slow. Control helps avoiding errors but increases response times. There is consensus that control does comprise several different functions, such as: detecting conflicts between cognitive representations, switching between different tasks, sustaining information in short term memory, or inhibiting inappropriate representations (Stuss et al., 1995). The controlled processes that are crucial in the noise-compatibility-task involve the detection of conflicts between responses, error detection and response inhibition (Botvinick et al., 1999; Gratton et al., 1992; Kopp et al., 1996; Van't Ent, 2002).

1.2. Motivated attention

Incentive stimuli may be hedonically pleasing or discomforting. Accordingly, several researchers hypothesised two separate motivation systems that are triggered by positive and negative incentive stimuli, respectively (e.g. Cacioppo and Gardner, 1999; Davidson, 2000; Carver, 2001). Positive incentive stimuli are associated with appetitive motivation, they promote positive feelings, and induce an action tendency of approach. Unpleasant stimuli activate a defensive motivation system, they come along with unpleasant feelings, and therefore make an organism escape from the situation or avoid it (Davidson, 2000). We will now discuss several contrasting predictions about how states of appetitive or defensive motivation may influence performance in a noise-compatibility-task.

1.2.1. Appetitive motivation

Some authors argue that approach motivation (inducing positive feelings) is likely to improve performance in controlled processing tasks. The theory proposed by Ashby et al. (1999) provides a neuropsychological approach. Positive mood states result in increased dopamine levels in the brain, particularly in the prefrontal cortex (PFC) and the anterior cingulate (ACC). These structures are known to be involved in several cognitive tasks that demand controlled processing, for example the Stroop-task (e.g. Steel et al., 2001), negative priming (e.g. Metzler and Parkin, 2000) and the noise-compatibility-task (e.g. Botvinick et al., 1999; Casey et al., 2000; Hazeltine et al., 2003). According to Ashby et al. (1999) increased dopamine levels lead to better performance in tasks that involve these structures (similar arguments are employed by Servan-Schreiber et al., 1998). Servan-Schreiber et al. (1998) provided first evidence for the dopamine hypothesis of controlled processing, they found that a dopamine agonist improved reaction times and accuracy only in the incompatible condition of a noise-compatibility-task. Taken together, these arguments suggest a positive influence of approach motivation on the capabilities of the cognitive system to resolve response conflicts.

On the other hand, some authors argue that a state of approach motivation may impair controlled processes, especially when paradigms similar to the noise-compatibility-task are considered. The theoretical outline in Bush et al. (2000) proposes an inhibiting relation between cognitive and affective subdivisions of the ACC. This suggests a reduction of control processes, when executive processing is accompanied by affective processing. Two studies used mood induction to investigate the effect of positive affect on the Stroop-task. Phillips et al. (2002) report larger Stroop effects in subjects after induction of positive mood. However, this contrasts with results from Kuhl and Kazen (1999). They found reduced Stroop interference after a positive cue, but only in the second of two consecutive trials.

Data from personality research suggest that appetitive motivation improves automatic processing at the expense of control. Impulsivity is considered to be caused by an increased trait activation of an appetitive motivation system. According to findings from Avila and Parcet (1997) impulsive subjects show less inhibition in a negative priming task. Furthermore, impulsive women show a greater noise-compatibility-effect than non-impulsive women. This suggests that impulsivity comes along with less effective inhibition and increased automatic processing (because automaticity strengthens the noise-compatibility-effect; Gratton et al., 1992). Similar results were evident in the study of Visser et al. (1996) in a sample of children. But they found an influence of impulsivity only on negative priming, but not on the Stroop-task.

To summarize these arguments, there is considerable evidence that suggests a relation between processes of controlled conflict resolution and appetitive motivation, but its direction is quite unclear, yet.

1.2.2. Defensive motivation

As Norman and Shallice (1986) have outlined, *dangerous* situations (among several others) trigger controlled processing. Does that mean that more controlled attentional processing takes place, when subjects are threatened with punishment and consequently a defensive motivation system is activated?

Fox (1994) formulated the hypothesis that high anxious subjects suffer from a general deficit to inhibit distracting information. The evidence concerning this hypothesis is contradictory. Fox (1993) did not show an increased Stroop interference in high anxious compared to low anxious subjects. The data did show that high anxious subjects