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Need for cognition relates to low-level visual performance in a metacontrast masking paradigm

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ABSTRACT

Need for cognition (NFC) refers to dispositional differences in cognitive motivation and has been frequently found to predict higher-order cognition, such as attitude formation and decision making. Based on recent evidence, this study examined whether NFC already relates to relatively early perceptual processes. Using a metacontrast masking paradigm ($N = 137$), we found that high-NFC individuals were more likely to use target-specific perceptual cues providing valid information for target discrimination, while low-NFC individuals were more likely to use less reliable heuristic cues for their judgement. Intriguingly, our results suggest that core mechanisms of NFC (focussed/elaborative vs. peripheral/heuristic processing by differential utilization of environmental cues) can not only be found in reflective higher-order cognition, but similarly in behavioral indicators of early visual processing.

1. Introduction

Research on individual difference variables that modulate the level of information processing is of fundamental importance for the understanding of adaptive behavior in complex environments. In the field of personality, for example, the trait need for cognition (NFC, Cacioppo & Petty, 1982) has stimulated considerable interest. Specifically, NFC refers to dispositional differences in *cognitive motivation* and is conceptualized as the intrinsic motivation to engage in and enjoy effortful cognitive endeavors (e.g., Cacioppo, Petty, Feinstein, Blair, & Jarvis, 1996). A large body of research shows that NFC impacts on a range of cognitive behavior, including the elaboration, evaluation, and recall of information as well as attitude formation and change, problem solving, and decision making (for overviews, see Cacioppo et al., 1996; Petty, Briñol, Loersch, & McCaslin, 2009). Accordingly, individuals scoring high in NFC rely more on the quality of arguments in persuasive messages (e.g., Haddock, Maio, Arnold, & Huskinson, 2008) and tend to have more resistant attitudes than those low in NFC (e.g., Haugtvedt, Petty, & Cacioppo, 1992). Moreover, they are more likely to think about their thoughts (Petty, Brinol, & Tormala, 2002), actively search for new information (Verplanken, Hazenberg, & Palenewen, 1992), and prefer complex to simple tasks (Cacioppo & Petty, 1982; See, Petty, & Evans, 2009). As a consequence of their higher cognitive engagement they showed improved results in cognitive tasks such as better memory performance (e.g., Kardash & Noel, 2000) and higher accuracy in decision making (e.g., Levin, Huneke, & Jasper, 2000).

NFC-specific differences have been related to theoretical considerations of dual-process models such as the *elaboration likelihood model* (ELM) as suggested by Petty and Cacioppo (1986). This model proposes two routes of information processing: a so called central route that is based on focused/elaborate processing of reliable and decision-relevant information (e.g. during impression formation) and a peripheral route that is associated with less effortful processing relying on heuristics or less relevant information. The depth of processing that determines which route of processing is used can be moderated by situational and ability factors, but also was found to depend strongly on the cognitive motivation that is engaged during information processing. NFC, thus is related to the ELM in the way that individuals high in NFC typically focus more on relevant information and show central-route based processing whereas individuals low in NFC are more likely to rely on simple cues, heuristics and peripheral processing (Cacioppo, Petty, Kao, & Rodriguez, 1986).

In contrast to research on the behavioral consequences of NFC-related differences, studies determining the question of associated or underlying perceptual and cognitive processes that may shape NFC-specific behavior are still sparse. Studies on the relationship of NFC to cognitive abilities have found that NFC is moderately correlated with fluid and crystallized aspects of intelligence (e.g., Day, Espejo, Kowollik, Boatman, & McEntire, 2007; Fleischhauer et al., 2010). On a more basic level, using the EEG and event-related brain

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potentials (ERP) providing temporal and functional information on NFC-related processing, Enge, Fleischhauer, Brocke, and Strobel (2008) showed that NFC is associated with bottom-up and top-down driven attention (see also Corbetta & Shulman, 2002). Specifically, the authors observed NFC to be positively correlated with the target-evoked P3b component in a novelty oddball paradigm indicating voluntary controlled attention to motivationally relevant stimuli. Moreover, and even more interesting, high-NFC individuals showed larger amplitudes in the late P3a component to contextually novel events, indicating greater involuntary (automatic) attention allocation. Intriguingly, these results that were drawn from two independent samples suggest that NFC-specific differences might already refer to involuntary and preconscious processes that can be linked to early attention and perception. Interaction results between NFC and a genetic variation of the serotonin transporter (5-HTTLPR) on the N1 component, which peaks around 100 ms after stimulus onset, and thus at the perceptual processing level, may support this notion (Enge, Fleischhauer, Lesch, & Strobel, 2011).

2. Current research: NFC and lower-level visual perception

The present research went a step further and attempted to shed light on the question whether individual differences in NFC are already reflected in low-level perceptual processes that are linked to higher levels of information processing (Breitmeyer & Ogmen, 2006; Miller, Rammsayer, Schweizer, & Troche, 2010).

In the current study, a metacontrast masking paradigm served as indicator of lower level visual perception. In metacontrast masking as a type of backward masking, the visibility of an otherwise fully visible target stimulus is decreased by a subsequently presented masking stimulus, whose inner contours neatly fit the outer contours of the target stimulus. In the metacontrast task used in this study, target and mask stimuli were of square and diamond shape with one half of trials providing consistency between target and mask shape whereas in the other half of trials target and mask were incongruent in shape (for details on the metacontrast task, see Section 3.2.2 and Fig. 1A and B). Under these conditions target visibility is a function of the stimulus onset asynchrony (SOA) between the target and the mask (Breitmeyer & Ogmen, 2006). Recent evidence (Albrecht, Klapotke, & Mattler, 2010; Albrecht & Mattler, 2012a; Albrecht & Mattler, 2012b; Maksimov, Murd, & Bachmann, 2011) suggests stable individual differences in the time course of these masking functions: In a discrimination task of metacontrast masked targets, some participants show increasing performance with increasing SOA (type-A observers), whereas other participants' performance decreases with increasing SOA (type-B observers). These differences have been shown to be stable over time and different situations, and were attributed to the perception and use of specific perceptual cues that are applied spontaneously when performing the task. As shown by Albrecht and Mattler (2012b), type-A observers mainly perceive and rely on rotational motion cues in the target-mask sequence that are most reliable at long SOAs whereas type-B observers base their target responses mainly on negative afterimages of the target that appear to be reliable only at short SOAs (see also, Stewart, Purcell, & Pinkham, 2011). As rotational motion is only perceived if target and mask are incongruent in shape, type-A individuals have been observed to rely on the simple strategy to respond to the shape of the mask when no rotation was observed (Albrecht & Mattler, 2012a). At short SOAs, however, at which the motion cue cannot be reliably perceived, this heuristic misleads the perceiver to the wrong conclusions that target and mask are congruent resulting in a response bias towards the shape of the mask instead of that of the target (see also Schmidt, 2000).

As reported above, individuals high in NFC tend to be engaged in focused processing towards the most relevant information of a given context whereas individuals low in NFC are more likely to focus on simple cues and peripheral processing. This NFC-specific processing might be modulated by early perceptual processes of stimulus attributes and perceptual cues. With respect to the metacontrast paradigm that tap into these low-level perceptual processes, we hypothesize that high-NFC individuals rather rely on target-related perceptual cues (type-B) whereas those low in NFC rather rely on the heuristics provided by motion cues (type-A) and that, therefore, NFC will be correlated with changes in performance between short and long SOAs.

3. Method

3.1. Participants and experimental design

The sample consisted of 137 students of Georg-August University Göttingen (85 female, age mean ± *SD* 23.7 ± 3.3 years, range 18–35 years). All had normal or corrected to normal vision, gave written informed consent prior to testing and received course credit or monetary compensation. Participants completed the NFC questionnaire and one of six experiments on metacontrast masking in a counterbalanced order. The six experiments were focused on investigating individual differences in visual masking and conscious perception (Albrecht & Mattler, 2012b; Albrecht et al., 2010) and are similar with regard to the stimulus conditions (see supplement for details).

3.2. Measures

3.2.1. NFC questionnaire

NFC indicators were obtained from the German 16-item NFC questionnaire (Bless, Wanke, Bohner, Fellhauer, & Schwarz, 1994). Each item was rated on a seven-point Likert-scale ranging

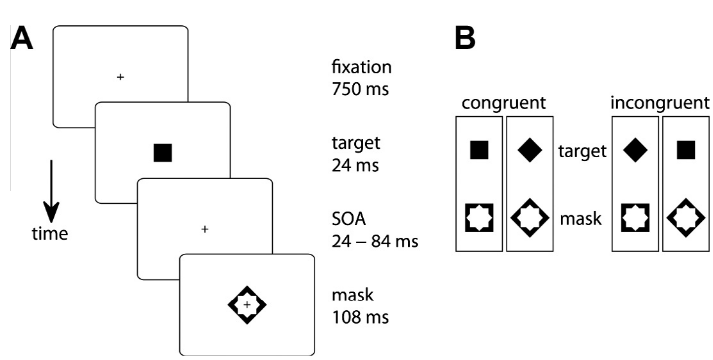

Fig. 1. Trial sequence and stimuli in the discrimination task. (A) Sequence of events. (B) Possible combinations of target and masking stimuli.