Journal of Research in Personality 55 (2015) 10–13

Contents lists available at ScienceDirect

Journal of Research in Personality

journal homepage: www.elsevier.com/locate/jrp

Brief Report

Explicit and implicit Need for Cognition and bottom-up/top-down attention allocation

Alexander Strobel [a,*], Monika Fleischhauer [a], Sören Enge [a], Anja Strobel [b]

[a] Department of Psychology, TU Dresden, D-01062 Dresden, Germany
[b] Department of Psychology, TU Chemnitz, D-09107 Chemnitz, Germany

ARTICLE INFO

Article history:
Available online 22 November 2014

Keywords:
Need for Cognition
Implicit Association Test
Novelty oddball
Electroencephalogram
Event-related potential
P3a
P3b
Attention allocation

ABSTRACT

Need for Cognition (NFC), the tendency to engage in and enjoy thinking, is usually directly measured via self-report. In order to validate an indirect NFC Implicit Association Test, we followed up on evidence suggesting NFC to be related to electrocortical indicators of bottom-up and top-down attention allocation in an oddball paradigm. In 99 participants, we did not find effects of directly and indirectly measured NFC on the processing of task-irrelevant stimuli, but found a main effect of explicit NFC on bottom-up target processing and an interactive effect of explicit and implicit NFC on top-down target processing. These findings further implicate NFC in the modulation of attention allocation and highlight the usefulness of direct *and* indirect measures in individual differences research.

1. Introduction

Need for Cognition (NFC) refers to an individual's tendency to engage in and enjoy effortful cognitive endeavors, with individuals high on NFC engaging in *central processing* and deep elaboration of information, and individuals low on NFC engaging in rather *peripheral processing* and shallower elaboration. There is ample evidence for NFC being a useful predictor of individual differences in information processing in a variety of research fields (for review, see Cacioppo, Petty, Feinstein, & Jarvis, 1996).

So far, NFC has usually been directly measured via self-reports using the NFC scale (Cacioppo & Petty, 1982). However, as individuals might not always be willing or able to correctly report on their behavior, indirect performance-based measures such as the Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998) have been developed and have been proven to be suitable for the assessment of individual differences (e.g., Back, Schmukle, & Egloff, 2009). In order to foster research on the role of NFC in information processing, we developed an NFC-IAT and provided initial validation results by showing that it exhibited good predictive validity and explained variance in NFC-typical behavior over and above the NFC scale (Fleischhauer, Strobel, Enge, & Strobel, 2013).

With the present study, we sought to further validate the NFC-IAT by following up on previous research on the role of NFC in attention allocation (Enge, Fleischhauer, Brocke, & Strobel, 2008). In that study, we examined NFC-related differences in attention allocation during an auditory novelty oddball task and used event-related potentials (ERPs) of the electroencephalogram (EEG), the so-called P3a and P3b, as indicators. The P3a is more pronounced to deviant stimuli and has been suggested to mirror involuntary, bottom-up driven processing of salient events of potential behavioral significance (e.g., Daffner et al., 2000). The P3b is more pronounced to targets and is assumed to reflect the amount of attentional resources voluntarily invested in stimulus processing (e.g., Polich, 2003). We observed P3b responses to targets and P3a responses to novel, complex distracting sounds to be positively related to explicit NFC (Enge et al., 2008), suggesting that NFC-specific processing is related to voluntary, top-down driven aspects of attention allocation, but also relies on involuntary, bottom-up driven attention allocation, which may facilitate later conscious elaboration.

In the present study, we expected an enhanced P3a for individuals with higher explicit NFC and were interested, whether implicit NFC would show additive or interactive effects. We assumed implicit NFC – capturing more impulsive, preconscious aspects of NFC-related processing – to be more strongly related to the primarily bottom-up modulated P3a, and explicit NFC – capturing more reflective, conscious aspects of NFC – to be more strongly related to the primarily top-down modulated P3b. Furthermore, we were interested in whether implicit and explicit NFC would be related to the processing of distracting novelty or

* Corresponding author. Fax: +49 351 463 36993.
E-mail address: alexander.strobel@tu-dresden.de (A. Strobel).

http://dx.doi.org/10.1016/j.jrp.2014.11.002

complexity and therefore introduced a novelty oddball task that enabled us to disentangle preferential novelty and complexity processing.

2. Methods and materials

2.1. Sample

From 122 TU Dresden students recruited, 23 were excluded from the final analyses based on inferior behavioral performance (see below). The final sample (99 participants, 50% female, mean age ± *SD*: 21.8 ± 2.2 years) gave written informed consent to take part in the study (approved by the TU Dresden Ethics Committee), and received monetary compensation of 15 EUR or course credit for their participation. All participants were right-handed and confirmed that they were free of relevant past and present health problems and had consumed only minimal amounts of legal drugs during the past 24 h.

2.2. Measures

Explicit NFC (*eNFC*) was assessed using the short 16-item German NFC scale (Bless, Wänke, Bohner, Fellhauer, & Schwarz, 1994; scale characteristics in the present study: $M = 17.3$, $SD = 1.4$; Cronbach's $\alpha = .82$). Implicit NFC (*iNFC*) was assessed using the NFC-IAT with the target categories «Me» and «Me Not» and the attribute categories «fathom» and «relax» (Fleischhauer et al., 2013). The IAT effect ($M = -.19$, $SD = .34$) was calculated using the D_1 measure (Greenwald, Nosek, & Banaji, 2003) with higher values indicating higher implicit NFC. The NFC-IAT's split-half reliability was .91. The direct and indirect NFC measures were not correlated, Spearman's $\rho = .11$, $p = .30$.

The oddball task consisted of four types of three-stimulus oddball blocks, being presented in a counterbalanced manner across participants, who were required to respond to target stimuli by a button press and to ignore all other stimuli. In each block, 320 standard sine tones, 40 target sine tones, and 40 deviant stimuli (all with a duration of 400 ms and presented with an average stimulus onset asynchrony of 1100 ms) were presented in pseudorandomized order. Standard, and target tones, were tones of 300, or 400 Hz, respectively, while the deviant stimuli were selected to be either novel or repetitive (high vs. low novelty), and either complex sounds or simple tones (high vs. low complexity). The novel sounds (NS; both complex and novel) were environmental sounds established by Fabiani and Friedman (1995), being presented only once per block. The repetitive sounds (RS; complex, but not novel) were different sounds from the same source, being presented repeatedly within one block. The novel tones (NT; not complex, but novel) comprised sine tones ranging from 500 to 1525 Hz, being presented only once per block. The repetitive tones (RT; neither complex nor novel) were 1400 or 1500 Hz sine tones, being presented repeatedly within one block. Together with an initial demonstration of the stimuli to be presented in the upcoming block and with a variable number of dummy stimuli per block, one block lasted about eight minutes; the total task took about 40 min.

2.3. EEG recording and ERP analyses

EEG was recorded (band-pass .1–250 Hz, sampling rate 500 Hz) from 29 sites of the enhanced 10–20 system using Ag/AgCl electrodes, with mastoids as reference and AFz as ground. The high-pass (.2 Hz) filtered EEG was submitted to an infomax independent component analysis to remove muscular, eye-related, and electrical noise artifacts using EEGLAB (Delorme & Makeig, 2004). Then, −200 to 800 ms epochs for all target and deviant events were 30-Hz-lowpass-filtered, averaged, and submitted to an unrestricted, unscaled temporal principal components analysis based on the covariance matrix, followed by Varimax rotation, in order to decorrelate the spatially and temporally overlapping P3a and P3b components (for further details, see Enge et al., 2008). Among the 76 extracted and rotated factors (accounting for 99.999% of the variance), two were interpreted as P3-factors based on their spatiotemporal correspondence with the ERP: Factor 1 (P3b; 27.5% explained variance) peaked at 484 ms after stimulus onset with a posterior distribution. Factor 3 (P3a; 25.5%) peaked at 316 ms with a frontocentral distribution.

2.4. Statistical analyses

All statistical analyses were carried out with SPSS 21 (IBM Germany, Ehningen, Germany). Behavioral analyses indicated that 23 of the 122 examined participants had obviously either misunderstood or not followed the rather clear and repeatedly presented instructions. Their response pattern was characterized by low hit rates on targets and/or high false alarm rates on deviants, so they were discarded from further analyses. The low behavioral variability of the remaining 99 participants (hit rates: $M > 0.98$, $SD < 0.03$; false alarm rates: $M < 0.04$, $SD < 0.04$) precluded further analyses of the performance data.

With regard to the ERP data, we focused on NFC-related effects (task-related effects will be published elsewhere). We first averaged the P3a and P3b factor scores for the different deviant and target conditions across electrode positions Fz, Cz, and Pz in order to capture the maximum of ERP information and to reduce the complexity of subsequent analyses. Then, novelty and complexity indices were calculated as difference scores (novel sounds and tones minus repetitive sounds and tones, and novel and repetitive sounds minus novel and repetitive tones, respectively), separately for deviants and for targets in the different distractor contexts, and for P3a and P3b factor scores, respectively. This enabled us to distinguish P3a responses to deviants with regard to their novelty and complexity. Likewise, P3b responses to targets in contexts characterized by distracting novelty or distracting complexity could be distinguished.

The novelty and complexity indices were entered into four separate repeated-measures analysis of variance (ANOVA) with the within-subjects factor *Condition* (novelty vs. complexity). In a first step, only *eNFC* and *iNFC* were entered as continuous between-subjects variables, their product (i.e., the implicit-explicit interaction) was entered in a second step. All variables except for the latter were centered by mean-subtraction in order to enhance the interpretability of effects via simple slope graphs based on ANOVA regression coefficients calculated using a custom Excel sheet (http://www.jeremydawson.com/2-way_unstandardised.xls). Significant results will be presented with a full description of the test statistics; for insignificant results, only the p value will be presented (with effect sizes, partial eta-square, η_p^2 being below 0.02, mostly even below 0.01). Estimated power to detect an effect equaling $r = .30$ at a two-tailed α-level of .05 was about .90 in the present sample.

3. Results

Concerning the P3a on deviants – assumed to reflect bottom-up attention allocation to individually relevant distracting events – neither *eNFC* nor *iNFC* had significant main effects at both ANOVA steps, all $p \geqslant .71$; a visible interaction (Fig. 1A–B) was insignificant, $F(1,95) = 1.76$, $p = .19$, $\eta_p^2 = .02$, as were the within-between interactions of *Condition* with NFC at both steps, all $p \geqslant .34$. For