



Research report

Encoding/retrieval dissociation in working memory for human body forms

Denise A. Soria Bauser*, Kerstin Mayer, Irene Daum, Boris Suchan

Institute of Cognitive Neuroscience, Department of Neuropsychology, Ruhr University Bochum Universitätsstraße 150 D-44780 Bochum, Germany

ARTICLE INFO

Article history:

Received 31 August 2010
 Received in revised form
 27 November 2010
 Accepted 17 January 2011

Keywords:

Working memory
 Body perception
 N170
 P3b
 Configural processing

ABSTRACT

The present study was conducted to investigate the effect of working memory (WM) load on body processing mechanisms by using event-related potentials (ERPs). It is well known that WM load modulates the P3b (amplitude decreases as WM load increases). Additionally, WM load for faces modulates earlier ERPs like the N170. The present study aimed to investigate the effect of WM load for bodies on the P3b which is associated with WM. Additionally, we explored the effect of WM load on the N170, which is thought to be associated with configural processing, and P1, which has been observed in body as well as in face processing. Effects were analyzed during the encoding and retrieval phases. WM load was modulated by presenting one to four unfamiliar bodies simultaneously for memory encoding.

The present study showed that early encoding processes (reflected by the P1 and N170) might not be modulated by WM load, whereas during the retrieval phase, early processes associated with structural encoding (N170) were affected by WM load. A possible explanation of the encoding/retrieval differences might be that subjects used distinct processing strategies in both phases. Parallel encoding of the simultaneously presented bodies might play an important role during the encoding phase where one to four bodies have to be stored, whereas serial matching might be used to compare the probe with the stored pictures during the retrieval phase. Additionally, WM load modulations were observed in later processing steps, which might be associated with stimulus identification and matching processes (reflected by the early P3b) during the encoding but not during the retrieval phase. The current findings further showed for both the encoding and the retrieval phase that the late P3b amplitude decreased as WM load for body images increased indicating that the late P3b is involved in WM processes which do not appear to be category-specific.

© 2011 Elsevier B.V. All rights reserved.

1. Introduction

During the last years, the processing of human faces received much attention due to its social relevance. Recently, studies focused on mechanisms involved in body form perception and many parallels between face and body perception have been found so far (for reviews, see [1,2]). The present study aimed to investigate the effect of working memory (WM) load on body processing mechanisms by using event-related potentials (ERPs).

WM is involved in temporary storage and manipulation of information for several seconds [3–5] and seems to be a multicomponent process consisting of a central executive and three distinct storage buffers [3,4]: the visuospatial sketch pad (visual WM), the articulatory loop and the episodic buffer. The present investigation will focus on the visuospatial sketchpad of WM, which has a limited storage capacity like all WM components [5,6]. The limits of the WM capacity can be determined by varying the WM load, which is the amount of information or number of items maintained in WM at the

same time. The WM capacity for visual objects is limited to approximately four objects [6,7]. However, there is evidence that it is additionally affected by the nature of the object to be stored, object complexity [8–11] and inter-item similarity [12]. More recent work suggested that WM capacity depends on the nature of the object perception process [13,14] defined as a specific strategy to perceive a stimulus (e.g., feature-based, configural). Generally, objects are perceived in a feature-based manner, whereas some stimulus types (especially faces and bodies) underlie configural processing mechanisms [1,15–17], which is defined as perceiving relations among the features of a stimulus [15,17]. Configural processing is an advantage for the efficient storage of objects and results in increased WM capacity for faces compared to other objects of similar visual complexity [13].

To investigate the effect of object perception processing on visual WM for faces, Morgan et al. [14] conducted an event related potentials (ERPs) study. They aimed to explore the time course of the effect while focusing on the following ERP components: P1, N170, N250r, early and late P3b, which are described in detail below.

The P3b – as a subcomponent of the P300 – is a positive peak around 300 and up to 900 ms over posterior-parietal scalp areas [18,19]. Furthermore, the P3b is strongly associated with WM and

* Corresponding author. Tel.: +49 0 234 32 23574; fax: +49 0 234 32 14622.

E-mail addresses: Denise.Soria-Bauser@rub.de, denise.minnebusch@rub.de (D.A. Soria Bauser).

an attentional updating process which is involved in the detection of a new stimulus in an array of standard stimuli [19,20]. With regard to WM load, subsequent attentional engagement is reflected by an increase of task processing demands, which again is due to increasing WM load leading to an attenuation of the P3b amplitude [18,21]. This inverse relationship of WM load and P3b amplitude supports the idea of resource allocation from the stimulus classification and response decision-making component to the WM maintenance component [21]. The visual P3b is generated by the interplay of parietal regions and the inferior temporal cortex [22]. In simple tasks, the P3b consists of just one peak, but using complex tasks (e.g., delayed discrimination tasks), time courses of the P3b reveal two subcomponents [22]. The early P3b is generated in inferior temporal cortex, left temporo-parietal junction and posterior parietal cortex (PPC) around 366 ms after stimulus onset. Activity of the PPC and ventrolateral prefrontal cortex (VLPFC) appears around 585 ms after stimulus presentation contributing mainly to the late P3b [22]. This distinction supports the idea of Kok [18] that the P3 is not a unitary phenomenon but the summation of activity that is widely distributed over the brain and in time. It has been suggested that in the context of visual WM retrieval, the early P3b might reflect stimulus evaluation. Stimulus evaluation has been defined as any process that appears before a motor action has been selected or prepared [see 18]. The late P3b might be related to memory search processes which access a posterior parietal storage buffer [22]. Alternatively, the late P3b might be associated with higher WM control mechanisms [14,22]. Memory search processes or higher WM control mechanisms are only necessary in complex tasks, but stimulus evaluation is sufficient in simple tasks. This suggests that only the late P3b should be influenced by WM load, an idea that is supported by a study of Morgan et al. [14].

The N170 is a negative deflection that occurs around 170 ms after stimulus onset at occipito-temporal electrodes and N170 reflects an early perceptual stage of face processing which is associated with the structural encoding of a face [23,24]. The P1 as the first positive deflection around 100 ms after stimulus onset is the earliest index of endogenous low-level feature processing of visual stimuli [25] and associated with short-term memory success [26].

In a delayed recognition task with varying WM load from one to four faces, Morgan et al. [14] observed that the P3b was divided into two subcomponents in the encoding and retrieval phases. Both subcomponents decreased with increasing WM load in the retrieval phase. However, in the encoding phase, only the late P3b was reduced by WM load supporting the idea of two distinct functional and anatomical subsystems. Furthermore, Morgan et al. [14] raised the issue that if WM capacity is influenced by object perception processes, neural effects of WM load may be found for earlier processing stages as well [see 27–30]. If this were the case, WM load should affect face sensitive ERPs (P1 and N170) as well. Morgan et al. [14] reported an increase of the N170 amplitude with WM load during the encoding period and a decrease during the retrieval period. As the N170 is thought to reflect configural processing, they concluded that the modulation of the N170 by WM load indicates that WM capacity limitations are reflected in early stages of face processing. In addition, Morgan et al. [14] found an increase in P1 amplitude for faces with increasing WM load from load 1 to load 2 in the encoding period but no significant effect in the retrieval period.

Recently, it was observed that configural processing occurs not just for face processing but also for the processing of human bodies [16,31]. Brain areas responding selectively to human bodies (extrastriate body area and fusiform body area) are located close to brain areas responding to face stimuli (occipital face area and fusiform face area) but can still be distinguished from them [1,2,32–34]. Evidence for configural processing of body forms comes from the inversion effect for bodies similar to that for faces

[16,35]. Furthermore, faces and bodies elicited comparable N170 amplitudes [36,37]. Thierry et al. [37] observed an enhanced P1 latency not only for faces but also for bodies compared to other objects, indicating P1 sensitivity to bodies. Additionally, in a classical paradigm of visual arrays with a varied number of simple objects in the array, the P1 was found to be task load sensitive with shorter latencies and increasing amplitude with enhanced task load [38]. Considering that the P1 and N170 are elicited by faces and bodies and that they are sensitive to WM load for faces, the P1 and N170 could be sensitive to WM load for body images as well. Based on the hypothetical parallel processing of faces and bodies, the current study aimed to investigate the effect of WM load for bodies on early and late P3b, N170 and P1 components.

Taken together, WM capacity seems to rely on the nature of the perceived object, as is obvious from studies investigating the processing of faces, which are one example of a configurally processed object category. ERPs involved in WM and early visual processing are modulated by WM load. Since faces and bodies involve similar processing mechanisms, ERPs evoked through body stimuli could be modulated by WM load as well. This would be further evidence for the important role of higher visual areas in WM for configurally processed stimuli. The current study investigated the influence of WM load on early and late P3b, N170 and P1 for bodies in the encoding and retrieval phases of a delayed recognition task.

2. Method

2.1. Subjects

Fourteen right-handed subjects (8 male, mean age 25.86 years, SD=2.77) participated in this study. All subjects had normal or corrected-to-normal vision and reported good neurological and psychological health. The study was approved by the Ethics Committee of the Medical Faculty of the Ruhr University Bochum, Germany and performed in accordance with the ethical standards laid down in the declaration of Helsinki [39]. Written informed consent was obtained from all subjects.

2.2. Stimuli

Gray-scaled photographs of twelve male subjects were displayed on a white background. Pictures were taken from a set of photographs of whole bodies of 30 males in natural postures, which was developed in our department [40]. Fifteen subjects (7 male, mean age 29.8 years, SD=7.5), who were different from the ones participating in the present study, rated the stimuli as typical male bodies in a neutral position. To minimize face processing during the presentation of bodies, the faces were masked [31,40].

2.3. Procedure

Participants were seated in a sound-attenuating and electrically shielded room, facing a computer monitor at a distance of 80 cm. They were instructed to avoid eye and body movements as well as excessive blinking.

The task followed the procedure of Morgan et al. [14] and consisted of an encoding and a retrieval phase lasting 2 s each. During the inter-trial interval, a black cross was presented for 1 s in the center of the screen. In the encoding phase, a display consisting of four stimuli was presented. The stimuli were displayed with 2° distance from a central black fixation cross (see Fig. 1). Between one and four of these stimuli (WM loads 1–4) were photographs of human body forms and the remaining stimuli were scrambled body pictures. The position as well as the number of presented body pictures were randomized. In the retrieval phase, one photograph of a human body form was presented in the center of the monitor. In half of the trials, the picture of the retrieval phase was identical with a photograph of the encoding phase. Starting with the display of the test body, subjects had 2 s from the onset of the test body to make the decision. The inter-trial interval was between 3.5 and 4.5 s (average 4 s).

The experiment contained 280 trials (70 in each WM load condition), divided into five blocks of 50 trials each and a sixth block of 30 trials. For each load condition in each block, half of the target bodies were matching and half were non-matching. The subjects' task was to decide via key presses as quickly and accurately as possible whether the body of the retrieval phase matched one of the bodies of the encoding phase.

2.4. EEG recordings

The EEG was recorded from 30 Ag/AgCl electrodes (10–20 standard set-up) mounted on an elastic cap. Four additional electrodes were placed above and below

Download English Version:

<https://daneshyari.com/en/article/4313773>

Download Persian Version:

<https://daneshyari.com/article/4313773>

[Daneshyari.com](https://daneshyari.com)