BRAIN RESEARCH 1557 (2014) 66–73

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Brain Research

Research Report

ERP profiles for face and word recognition are based on their status in semantic memory not their stimulus category

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ARTICLE INFO

Article history:
Accepted 4 February 2014
Available online 12 February 2014

Keywords:
Recognition-memory
Famous
Words
Early old/new effect
Late old/new effect
Faces

ABSTRACT

Previous research has suggested that faces and words are processed and remembered differently as reflected by different ERP patterns for the two types of stimuli. Specifically, face stimuli produced greater late positive deflections for old items in anterior compared to posterior regions, while word stimuli produced greater late positive deflections in posterior compared to anterior regions. Given that words have existing representations in subjects' long-term memories (LTM) and that face stimuli used in prior experiments were of unknown individuals, we conducted an ERP study that crossed face and letter stimuli with the presence or absence of a prior (stable or existing) memory representation. During encoding, subjects judged whether stimuli were known (famous face or real word) or not known (unknown person or pseudo-word). A surprise recognition memory test required subjects to distinguish between stimuli that appeared during the encoding phase and stimuli that did not. ERP results were consistent with previous research when comparing unknown faces and words; however, the late ERP pattern for famous faces was more similar to that for words than for unknown faces. This suggests that the critical ERP difference is mediated by whether there is a prior representation in LTM, and not whether the stimulus involves letters or faces.

Published by Elsevier B.V.

1. Introduction

Dual-process models have been influential in the study of recognition memory. These models propose that recognition depends both on familiarity, a relatively automatic process, and recollection, a more deliberate one (Jacoby, 1991; Yonelinas, 2002; Curran and Hancock, 2007). Consistent with a dual-process model, previous ERP research investigating

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http://dx.doi.org/10.1016/j.brainres.2014.02.010
0006-8993 Published by Elsevier B.V.

recognition memory typically describes canonical patterns of waveform differences between recognized (old) and correctly rejected (new) items that parallel the processes of familiarity and recollection. Specifically, the early old/new effect (also called the FN400), a negative component (more negative for new than old items) that appears around 400 ms over the anterior scalp, is thought to reflect familiarity, while the late old/new effect, a positive component (more positive for old than new items) that appears after 500 ms over the posterior scalp, is thought to reflect recollection (e.g., Curran, 1999; Curran and Doyle, 2011; Curran and Hancock, 2007; Diana et al., 2005; Graham and Cabeza, 2001; Paller et al., 2000; Wilding et al., 1995).

However, several recent studies have reported that the spatial and temporal distributions of these old/new effects differ for faces and words (e.g., MacKenzie and Donaldson, 2009; Yick and Wilding, 2008), raising the possibilities that faces are recollected differently from words, or that ERP correlates of memory retrieval for faces and words are material specific. While the early old/new effect for face stimuli has been inconsistently obtained in studies of recognition memory, the effects that have appeared are fairly similar to words. Yovel and Paller (2004), as well as MacKenzie and Donaldson (2007) found no early old/new effect for face stimuli. Curran and Hancock (2007), by contrast, did find an early old/new effect using a very similar paradigm with face stimuli.

In the study by Yick and Wilding (2008), early and late old/new effects were observed for faces and words, but the spatial distribution of these ERP components differed by stimulus type. An early old/new effect appeared over the anterior region for both faces and words. But from 500 to 800 ms, words showed the expected old/new effect with a parietal maximum, while this later old/new effect was maximal over the anterior scalp for face stimuli.

MacKenzie and Donaldson (2009) compared names with faces and found a pattern similar to that of Yick and Wilding. Comparing hits to correct rejections, they found that from 300 to 500 ms, faces and words showed similar early old/new effects. Consistent with Yick and Wilding, from 500 to 700 ms, the old/new effect evoked by faces was maximal over the anterior scalp, while the old/new effect evoked by words was maximal over the posterior scalp.

Taken together, these results suggest that the spatial distributions of the early (~400 ms) old/new effect are similar for faces and words, but the spatial distributions of the late (~600 ms) old/new effect differ. This difference has been taken as evidence that the late old/new effects for faces and words are categorically different, and that these differences are the product of specific attributes of the stimuli or their processing. In other words, the claim is that the neural activity engaged during memory retrieval will vary depending on the type of information (face or verbal material) that is recovered.

While this interpretation is plausible, another interpretation is worth considering. In each of these studies, stimulus type was confounded with whether the stimulus had a pre-existing (long-term) memory representation. The letter strings were words with meaning, but the faces were individuals unknown to the subjects. As such, it is difficult to tease apart whether the ERP effects were in fact driven by categorically different stimuli, or instead by the semantic/long-term memory representations (what we call "stable memory representations") of word stimuli and the absence of such pre-existing, stable memory representations for face stimuli. Evidence for the latter interpretation can be found in the known mnemonic differences between famous and unknown faces. For example, Reder et al. (2013) have found that famous faces are easier to bind to the encoding context than faces of people who are unknown to the subjects. Not only is recognition memory better for faces of known than of unknown people, but this advantage is particularly pronounced in recollection (as opposed to familiarity-based) memory judgments.

In this study, we sought to test the possibility that the observed ERP differences in episodic face recognition arise from differential processing of stimuli with and without a pre-existing representation in LTM. In order to disentangle stimulus type from status of pre-existing memory representations, we compare four stimulus conditions representing the two relevant factors: stimuli (faces vs. letter strings) × LTM representation stability (pre-existing memory representation vs. no pre-existing memory representation). The stimulus materials consisted of faces of celebrities, faces of unknown individuals, common words, and pseudo-words (meaningless pronounceable letter strings). If stimulus type is the critical factor that determines the topography of the late old/new effects, then we would expect to see a parietal late old/new effect for words and letter strings, and a more anterior late old/new effect for famous and unknown faces. Alternatively, if the pre-existing representation in LTM is the critical factor, then we would expect to see a parietal late old/new effect for famous faces and words, and a more anterior late old/new effect for unknown faces and letter strings.

2. Results

2.1. Behavioral results

During the encoding phase, accuracy was above 95% for all stimuli except famous faces (78%), reflecting the fact that subjects did not know all famous faces. Response time (RT) for correct letter strings was faster than for correct faces, $F(1,14)=17.16$, $p<0.001$. Within the letter string category, word RTs were faster than pseudo-words, $F(1,14)=9.21$, $p<0.01$. Within the face category, reaction times were equivalent for famous and unknown individuals ($p>0.05$).

Performance on the episodic memory test that followed encoding is shown in Table 1. Accuracy and RTs for correct judgments are shown as a function of whether the stimulus appeared earlier (old vs. new), whether the stimulus has a pre-existing representation (known vs. unknown), and whether the stimulus is a face or letter string. For completeness, the discrimination index (*Pr*) is also shown for each type of stimulus (Snodgrass and Corwin, 1988). This discrimination index is calculated as the hit rate minus the false alarm rate. Large values denote better performance.

For response accuracy, there were main effects of face vs. letter string, $F(1,14)=70.85$, $p<0.001$, and known vs. unknown, $F(1,14)=53.68$, $p<0.001$. Subjects responded more accurately to faces than to letter strings, and they responded