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Examining the neural basis of episodic memory: ERP evidence that faces are recollected differently from names

Graham MacKenzie [b,*], David I. Donaldson [a]

[a] Psychological Imaging Laboratory, Department of Psychology, University of Stirling, UK
[b] Department of Psychology, University of Glasgow, UK

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ABSTRACT

Episodic memory is supported by recollection, the conscious retrieval of contextual information associated with the encoding of a stimulus. Event-Related Potential (ERP) studies of episodic memory have identified a robust neural correlate of recollection—the left parietal old/new effect—that has been widely observed during recognition memory tests. This left parietal old/new effect is believed to provide an index of generic cognitive operations related to recollection; however, it has recently been suggested that the neural correlate of recollection observed when faces are used as retrieval cues has an anterior scalp distribution, raising the possibility that faces are recollected differently from other types of information. To investigate this possibility, we directly compared neural activity associated with remember responses for correctly recognized face and name retrieval cues. Compound face–name stimuli were studied, and at test either a face or a name was presented alone. Participants discriminated studied from unstudied stimuli, and made a remember/familiar decision for stimuli judged 'old'. Remembering faces was associated with anterior (500–700 ms) and late right frontal old/new effects (700–900 ms), whereas remembering names elicited mid frontal (300–500 ms) and left parietal (500–700 ms) effects. These findings demonstrate that when directly compared, with reference to common episodes, distinct cognitive operations are associated with remembering faces and names. We discuss whether faces can be remembered in the absence of recollection, or whether there may be more than one way of retrieving episodic context.

1. Introduction

The human episodic memory system allows the past to be re-experienced in the present (Tulving, 1983). The hallmark of episodic memory is recollection: the reinstatement of information about past events into conscious awareness. Recollection occurs when the processing of a retrieval cue reactivates memories associated with the cue (e.g., when the smell of baking bread brings a childhood visit to a bakery back to mind) and different types of retrieval cue are thought to elicit the same general process of recollection. In the present article we challenge the assumption that recollection is always associated with the same core cognitive operations; we present electrophysiological data that reveal dissociable neural correlates when recollection is elicited by face and name retrieval cues.

Recollection is not, of course, the only basis for making episodic memory judgments. *Dual process* models of recognition memory (e.g., Atkinson & Juola, 1974; Jacoby & Dallas, 1981; Mandler, 1980; Yonelinas, 1994) propose that a retrieval process called familiarity also supports episodic judgments. According to such models, a retrieval cue is assessed for its familiarity and if the level of familiarity is sufficiently high then the cue can be accepted as previously encountered, even if no contextual information about the original episode can be recollected. Familiarity is a fast-acting, relatively automatic process that provides a conscious feeling that an item has been experienced before. Importantly, from a theoretical perspective both familiarity and recollection are thought to be generic retrieval processes, operating across modalities and domains of information (see Yonelinas, 2002, for a review).

One important feature of dual process models is that recollection and familiarity are independent retrieval processes that elicit distinct phenomenological experiences, which can be assessed using the remember/know procedure (Tulving, 1985). 'Remember' responses are required when recognition is accompanied by the retrieval of specific details about the study episode (made on the basis of recollection), whereas 'know' responses reflect recognition without the retrieval of specific details (made on the basis of familiarity). While the remember/know procedure has been criticized for failing to completely isolate familiarity and recollection (e.g., Yonelinas & Jacoby, 1995; Wais, Mickes, & Wixted,

* Corresponding author at: Department of Psychology, Faculty of Information and Mathematical Sciences, University of Glasgow, 58 Hillhead Street, Glasgow G12 8QB, UK. Tel.: +44 0 141 330 3345; fax: +44 0 141 330 4606.
E-mail address: g.mackenzie@psy.gla.ac.uk (G. MacKenzie).

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2008), remember judgments are widely believed to be supported by relatively more recollection than familiarity, and as such the R/K procedure provides a useful measure of the contribution of recollection to recognition memory performance.

One of the strongest bases for dual process models is evidence from event-related potentials (ERPs: an electrophysiological method that can be used to provide a record of the neural activity evoked during performance of a cognitive task). ERP studies of recognition memory reveal differences in activity between correctly identified studied (old) and unstudied (new) stimuli, referred to as ERP 'old/new effects' (see Friedman & Johnson, 2000; Rugg & Curran, 2007, for reviews). In particular, an early (300–500 ms post-stimulus onset) modulation maximal over mid frontal scalp electrodes is associated with familiarity, while a later (500–700 ms) modulation maximal over left parietal scalp is linked with recollection. The mid frontal and left parietal old/new effects have been functionally dissociated by a number of task (e.g., Rugg et al., 1998) and stimulus (e.g., Greve, Van Rossum, & Donaldson, 2007) manipulations, providing strong evidence that the effects reflect distinct cognitive operations. While the left parietal effect appears to provide an index of recollection (Rugg & Yonelinas, 2003), the precise functional significance of the mid frontal effect remains contested, with some theorists arguing that it reflects familiarity (Rugg & Curran, 2007) and others contending that it may reflect conceptual priming processes that sometimes co-occur with episodic retrieval, particularly when words are used as stimuli (Voss & Paller, 2006; Paller, Voss, & Boehm, 2007).

The left parietal and mid frontal ERP old/new effects have also been dissociated from a number of other old/new effects, including a late posterior negativity (LPN, which has been associated with heterogeneous cognitive functions such as retrieval fluency and action monitoring; see Herron, 2007) and a late right frontal effect (typically associated with post-retrieval monitoring; Hayama, Johnson, & Rugg, 2008). Nonetheless, whilst other ERP old/new effects are evident, the majority of ERP retrieval studies have been interpreted within a dual process framework, and a wide range of evidence suggests that the left parietal effect provides a generic index of recollection—primarily because it has been observed with different stimulus materials (e.g., words—Donaldson & Rugg, 1998; line drawings—Curran & Cleary, 2003; landscape/object compound stimuli—Tsivilis, Otten, & Rugg, 2001) and for information that is presented in different modalities (Schloerscheidt & Rugg, 2004). Thus, consistent with dual process models, the left parietal effect is typically believed to be neither material- nor modality-specific and is considered to provide an index of core cognitive operations related to recollection.

Despite the foregoing evidence, in a recent study MacKenzie and Donaldson (2007) reported that recollection elicited by face retrieval cues was associated with an anterior old/new effect (400–600 ms; see Donaldson & Curran, 2007). In this experiment participants studied a series of photographs of faces, each presented with an auditory name. At test, old and new faces were presented, and participants made an initial old/new decision, and for faces judged old, were asked to report on any contextual information about the study episode that they retrieved. For recognition supported by familiarity, the ERP old/new effect was manifest over posterior scalp only (replicating the findings of Yovel & Paller, 2004), suggesting that recognition memory for faces is associated with a novel ERP signature of familiarity (and hence that there are multiple ERP signatures of familiarity). We note, however, that this finding could be interpreted as evidence against a familiarity account of the mid frontal old/new effect, providing indirect support for a priming interpretation. More importantly for present purposes, recollection-related ERPs elicited by face stimuli revealed a clear anterior old/new effect; this effect was larger when the associated names were retrieved than when other specific contextual information was retrieved. Although associated names were verbally reported and verified in the name condition, there was no verification of retrieved information in the other specifics condition; given that the two recollection-related effects were associated with the same scalp distribution the requirement to report on retrieved information did not affect the old/new effect in a qualitative manner. Critically, the anterior old/new effect was absent when contextual information could not be retrieved, suggesting a specific link with recollection.

Although MacKenzie and Donaldson (2007) was the first ERP study to describe a recollection-related anterior old/new effect, a comparable neural correlate of recollection appears to be present in previous experiments using non-verbal stimuli (Duarte, Ranganath, Winward, Hayward, & Knight, 2004, Fig. 8), including faces (Paller, Gonsalves, Grabowecky, Bozic, & Yamada, 2000, Fig. 4; Yovel & Paller, 2004, Fig. 2), leaving open the possibility that recollection may be supported by different cognitive operations under certain circumstances. In particular, a recent study compared face and word retrieval using a simple old/new recognition decision (Yick & Wilding, 2008). This study reported more anteriorly distributed old/new effects for faces than words; however, a clear functional interpretation of the anterior effect was not possible because trials where recognition was supported by recollection were not isolated, and because faces and words were encoded separately.

Despite evidence of anterior old/new effects, the proposal that recollection is associated with material-specific neural correlates cannot be accepted easily. Importantly, to date no ERP study has directly compared recollection elicited by word and face cues whilst holding the content of encoding episodes constant across face and name test trials (and hence limiting the possibility that differences at encoding acted as a confound). Thus, to add weight to this proposal, the present study aims to replicate the anterior recollection effect, using a similar paradigm as in MacKenzie and Donaldson (2007), but explicitly comparing recollection elicited by different types of retrieval cue.

In the present experiment participants studied a series of compound visual stimuli, each consisting of a face–name pair. Later, at test, a single element from each pair was presented, intermixed with unstudied faces and names. Importantly, each study episode was only ever probed once, with either the face or the name being presented as a retrieval cue. Participants were required to make an old/new discrimination for each test item, and made secondary remember/familiar decisions for each item judged old. These response options support inferences about the relative contributions of recollection and familiarity to test performance, and allow the identification of trials where recognition was supported by recollection. Given previous findings, we predicted that material-specific neural correlates of recollection would be observed across cue types—contrary to the pervasive view that recollection is supported by one homogenous set of cognitive operations.

2. Methods

Twenty-six right-handed native English speakers gave informed consent and took part in the study, which was approved by the Psychology Department ethics committee at the University of Stirling. Participants reported having normal or corrected-to-normal vision, and were paid £5 per hour. Data from two participants were discarded due to contamination with ocular artifacts. Of the remaining sample, 20 participants with a mean age of 20 years (range: 18–28) contributed a sufficient number of trials for ERPs to be formed for remember responses to correctly recognized faces and names, and therefore data from these 20 participants are reported here.

Faces and names were shown on a 17 in. LCD colour monitor; stimuli were presented and behavioural data were recorded with E-Prime (Psychology Software Tools; http://www.pstnet.com). Participants sat on a chair approximately one meter away from the monitor, with a button box on a desk in front of them. All faces were of young Caucasian individuals who did not wear any jewellery, glasses or facial hair. Two hundred and sixteen faces were presented during the experiment, and an additional four faces were used in a practice phase. Facial images were masked to