Brain and Cognition 96 (2015) 1–11

Contents lists available at ScienceDirect

Brain and Cognition

journal homepage: www.elsevier.com/locate/b&c

Sometimes we have to intentionally focus on the details: Incidental encoding and perceptual change decrease recognition memory performance and the ERP correlate of recollection

André Haese, Daniela Czernochowski *

Technical University Kaiserslautern, Kaiserslautern, Germany
Heinrich Heine University Düsseldorf, Düsseldorf, Germany

ARTICLE INFO

Article history:
Accepted 25 February 2015
Available online 21 March 2015

Keywords:
ERP
Familiarity
Recollection
Late parietal negativity
Intentional encoding
Perceptual focus

ABSTRACT

Prior studies suggest that memory retrieval is based on two independent processes: Recollection and familiarity. Here, we investigated the role of incidental and intentional encoding, and specifically whether perceptual changes between study and test affects behavioral and electrophysiological correlates of both retrieval processes. During retrieval, participants distinguished between identical and changed exemplars as well as novel distractors. Following incidental encoding, participants had difficulty identifying changed exemplars; item and feature recognition increased after intentional encoding, in particular for changed exemplars. Reflecting this increase in memory performance, the ERP correlate of recollection was larger after intentional encoding and for identical item repetitions, whereas the ERP correlate for familiarity was largely unaffected. Pre-response old/new effects corresponding to later aspects of recollection (700–1000 ms relative to stimulus onset) were larger in response-compared to stimulus-locked averages, but also of similar magnitude for identical and changed exemplars. These results corroborate previous findings suggesting that the electrophysiological signature of recollection is modulated as a function of memory performance. The role of task characteristics and material retrieved from memory for modulations in familiarity-based retrieval processes is discussed.

1. Introduction

When we go shopping for items we rarely use, we may find ourselves unable to remember which brand we bought last time. However, similar products are often found next to each other, so we need to retrieve specific features from memory to identify the product we chose last time – for instance the color of the bottle, the shape of it, or even the position in the shelf. According to numerous investigations, there are two independent processes supporting recognition memory retrieval in situations like that: Familiarity and recollection (Yonelinas, 2002). Familiarity-based retrieval supports the distinction between items encountered previously and new items, although details about the previous encounter are not retrieved along with the item itself. By contrast, recollection-based retrieval is an effortful and slower process, leading to highly confident memory judgments often based on additional details retrieved. Both processes can be dissociated based on behavioral characteristics (e.g., separating responses on the basis of reaction times, subjective reports of remembering or knowing, or contextual features remembered; for a review, see Yonelinas, 2002). In addition, event-related potentials (ERPs) allow to examine neural correlates of both processes at the speed in which they unfold. Familiarity is associated with more positive amplitudes for old compared to new items at frontal electrode sites (about 300–500 ms; e.g., Rugg & Curran, 2007), whereas recollection is associated with a parietal positivity for old compared to new items (about 500–800 ms; e.g., Wilding, 2000).

When additional details associated with studied items (e.g., word plurality, presentation modality, source) are remembered, the ERP correlate of recollection has been found to be larger (Curran, 2000; Curran & Cleary, 2003; Trott, Friedman, Ritter, & Fabiani, 1997; Trott, Friedman, Ritter, Fabiani, & Snodgrass, 1999; Vilberg, Moosavi, & Rugg, 2006; Wilding, 1999, 2000; Wilding & Rugg, 1997). By contrast, for the ERP correlate of familiarity, a more heterogeneous pattern of results has been reported, putatively at least in part a result of the different methodological approaches employed to investigate ERP correlates of recognition memory. When item attributes are modified between study and test phases

* Corresponding author at: Building 57, Room 575, Erwin-Schrödinger-Straße, 67663 Kaiserslautern, Germany.
E-mail address: czernochowski@sowi.uni-kl.de (D. Czernochowski).

http://dx.doi.org/10.1016/j.bandc.2015.02.003
0278-2626/

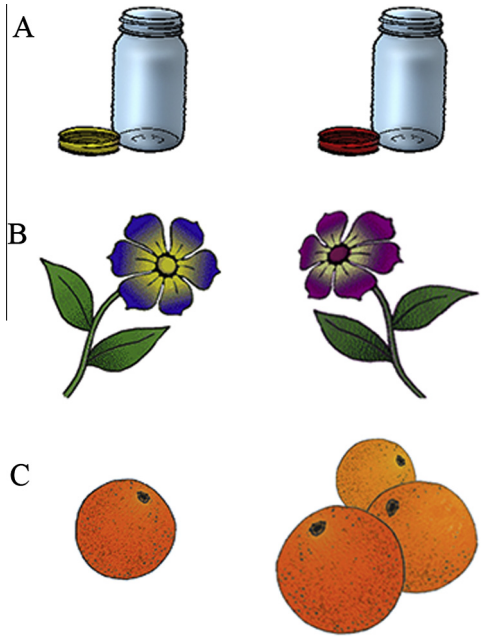

Fig. 1. Sample stimuli. These images illustrate the perceptual changes we used in this study (A: color; B: orientation and color; C: quantity and orientation). Note that we did not necessarily change only one dimension.

– for instance, items might be displayed in a different size, orientation, or color at test compared to their original format – these changed exemplars sometimes elicited a reduced (Ecker, Zimmer, & Groh-Bordin, 2007a; Tsivilis, Otten, & Rugg, 2001) or no ERP correlate of familiarity (Curran & Doyle, 2011, Experiment 2; Groh-Bordin, Zimmer, & Mecklinger, 2005). However, in other studies changing stimulus features between study and test did not affect the frontal old/new effect (Curran, 2000; Curran & Cleary, 2003; Curran & Dien, 2003; Czernochowski, Mecklinger, Johansson, & Brinkmann, 2005; Ecker, Arend, Bergström, & Zimmer, 2009; Friedman, Cycowicz, & Bersick, 2005; Wiegand, Bader, & Mecklinger, 2010). Zimmer and Ecker (2010) suggest that these inconsistencies can be explained by investigating subtle differences in stimulus attributes or task instructions: For instance, in some of the former studies, participants were asked to differentiate perceptually identical from perceptually changed items. In some of the latter studies, by contrast, perceptual features were not relevant for task execution, as perceptually changed and identical items both received an "old" response. Thus, when perceptual features are emphasized in a task, perceptual aspects of familiarity may become prominent; however, when perceptual features are less relevant for participants, familiarity may be based, to a larger extent, on conceptual features (e.g., more abstract semantic item content).

In addition to perceptually- and conceptually-driven task demands during retrieval (Zimmer & Ecker, 2010), the nature of encoding operations can also influence subsequent retrieval. Hence, the studies cited above can also be compared with respect to the tasks performed during the study phases: Previous memory studies used either (1) explicit instructions to focus on *specific* perceptual features during encoding which would become relevant during memory retrieval (e.g., Curran, 2000; Curran & Cleary, 2003; Ecker et al., 2007a), (2) explicit instructions about a subsequent memory test, but not regarding a potential distinction between old items and similar lures (e.g., Ecker, Zimmer, & Groh-Bordin, 2007b; Ecker et al., 2009; Groh-Bordin, Zimmer, & Ecker, 2006) or (3) incidental encoding in which participants were not aware of any subsequent test phase (e.g., Groh-Bordin et al., 2005; Küper, Groh-Bordin, Zimmer, & Ecker, 2012; Tsivilis et al., 2001; Wiegand et al., 2010). In addition, participants in previous studies sometimes completed multiple study-test cycles, including a practice of the test format before the learning phase, and were either explicitly instructed (e.g., Czernochowski et al., 2005) or could *infer* which aspects of the stimuli were relevant following the first test trials without explicit instruction. This point applies especially to those studies in which only a single attribute is modified (for instance plurality, color, size, left/right orientation, presentation modality; e.g., Curran & Doyle, 2011; Nyhus & Curran, 2012; Ranganath & Paller, 1999). After the first test phase, participants are likely to strategically adapt their attentional focus toward relevant stimulus features during subsequent encoding trials. Hence in the present study, incidental (participants are not informed about a subsequent test phase) and intentional (participants know about a subsequent test phase and hence intentionally encode items) study-test blocks were directly compared in order to systematically assess retrieval with and without perceptually fine-tuned encoding processes. Notably, participants could not predict which feature dimensions (e.g., size, color, specimen of object shown, orientation) would change between study and test phases to ensure that participants could not focus on one specific item feature in the second, intentional, encoding phase.[1] Thus, we assessed (1) to what extent details of an object with rich perceptual features can be recognized in an unexpected recognition test and (2) whether performance further increases when stimuli are memorized intentionally.[2]

Moreover, existing studies vary in the response requirements during retrieval: In some studies, "old" responses are given to both identical and changed items (e.g., Curran & Dien, 2003; Curran & Doyle, 2011; Ecker et al., 2009; Groh-Bordin et al., 2005; Küper et al., 2012; Ranganath & Paller, 1999, general test blocks; Tsivilis et al., 2001). In others, "new" responses are given to both changed items and novel distractors (e.g., Curran, 2000; Curran & Cleary, 2003; Ecker et al., 2007a, Experiment 2; Ranganath & Paller, 1999, specific test blocks). Furthermore, memory for perceptual features can be assessed by sequential prompting (first old/new discrimination, then identical/changed discrimination; e.g., Ecker et al., 2007a, 2009; Groh-Bordin et al., 2006; Wilding, Doyle, & Rugg, 1995) or by offering participants all three options (i.e., same/different/new) at once (e.g., Bader, Mecklinger, Hoppstädter, & Meyer, 2010; Ecker et al., 2007b; Nyhus & Curran, 2012). As changed items are not mapped to either identical or new items, this response format allows a more detailed classification of responses.

Finally, most ERP studies on memory retrieval focus on stimulus-locked averages (for exceptions, see de Chastelaine, Friedman, & Cycowicz, 2007; Johansson & Mecklinger, 2003). Time-locking the averages to the response onset, however, allows to evaluate

[1] Previous studies (e.g., Groh-Bordin et al., 2005; Küper et al., 2012) also kept participants from focusing on single item features. In these studies, participants were not asked to specifically memorize item features and were neither informed about feature changes. Also, they only had one test phase, so participants could not adapt their encoding strategy in any subsequent study phase. In contrast to most of the reviewed studies, our paradigm investigated the difference between incidental and intentional encoding and thus had to rule out the potential confound of a total strategy shift: To ensure comparable cognitive processes during study in both phases, in our paradigm it was not obvious which perceptual features of an item would be changed; hence participants could not selectively attend a single (predictable) item feature and thus process items on an entirely different level (e.g., by verbalizing "flower, blue").

[2] Note that previous studies compared retrieval after incidental and intentional encoding tasks in an oddball or related paradigms (e.g., see Cycowicz & Friedman, 1999, 2007; van Hooff, 2005). These papers focus on different theoretical and methodological aspects (e.g., targets are less frequent than standard stimuli and studied items are learned to criterion).