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Verbal predicates foster conscious recollection but not familiarity of a task-irrelevant perceptual feature – An ERP study

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ABSTRACT

Research on the effects of perceptual manipulations on recognition memory has suggested that (a) recollection is selectively influenced by task-relevant information and (b) familiarity can be considered perceptually specific. The present experiment tested divergent assumptions that (a) perceptual features can influence conscious object recollection via verbal code despite being task-irrelevant and that (b) perceptual features do not influence object familiarity if study is verbal-conceptual. At study, subjects named objects and their presentation colour; this was followed by an old/new object recognition test. Event-related potentials (ERP) showed that a study-test manipulation of colour impacted selectively on the ERP effect associated with recollection, while a size manipulation showed no effect. It is concluded that (a) verbal predicates generated at study are potent episodic memory agents that modulate recollection even if the recovered feature information is task-irrelevant and (b) commonly found perceptual match effects on familiarity critically depend on perceptual processing at study.

1. Introduction

Recognition memory refers to the ability to remember something previously experienced when it is encountered again. It is widely assumed that at least two distinct processes contribute to recognition memory: familiarity and recollection. Familiarity is usually considered a rather automatic process conveying a general feeling of knowing that something has been encountered before, without allowing conscious access to any specific episodic detail (such as the time and place of the previous encounter, or the name of a familiar person). On the other hand, conscious recollection is usually thought to involve the rather controlled retrieval of such specific spatiotemporal or featural detail associated with a study episode (for reviews, see Diana, Reder, Arndt, & Park, 2006; Ecker, 2007; Yonelinas, 2002; Zimmer, Mecklinger, & Lindenberger, 2006).

Hence, the two processes are associated with different conscious experiences. The process generating the familiarity signal is cognitively impenetrable (Fodor, 1983). Participants have conscious access to the result of this process, that is, the level of familiarity, but they cannot say what the basis of their feeling of familiarity is. In contrast, recollection is at least in part a cognitively penetrable process. Participants have the conscious experience that a stimulus was a member of a specific episode because they can retrieve contextual details, and they can communicate this (cf. Gardiner & Java, 1993).

It is furthermore assumed that a conscious experience at test requires a conscious experience at study. Moscovitch (1992) explicitly formulated this principle in his consciously-in/consciously-out hypothesis. If we apply this to a recognition

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experiment, we should expect that any manipulation that increases conscious processing during study should enhance recollection, simply because it generates possible candidates in memory for later recollection. Many observations of enhanced recognition performances after extended encoding operations could be quoted in support of this assumption. However, the variation of conscious encoding processes should not only influence memory performances, but also the electrophysiological correlates of recognition memory.

The two processes of familiarity and recollection have been associated with distinct and quite consistently found event-related potential (ERP) old–new effects. For example, the two ERP effects show differential sensitivity to depth-of-processing manipulations.[1] Familiarity is associated with an early (ca. 300–500 ms post test stimulus onset) mid-frontocentral ERP old–new effect, while a late (ca. 500–700 ms) left-parietal ERP old–new effect is thought to reflect recollection.

ERP old–new effects vary in amplitude with the quantity and quality of retrieved information (Vilberg, Moosavi, & Rugg, 2006; Vilberg & Rugg, 2007; Wilding, 2000). Hence, the degree of match between the accessed memory representation and the presented test probe will determine the old–new effects. Effect amplitudes are reduced if some information unit is present in both the probe and the reconstructed representation, but with mismatching values (e.g., someone you remember to be John is introduced as Jack). We refer to these kinds of effects as match effects. As will be discussed below, familiarity and recollection are assumed to rely on distinct memory representations. The content of these representations will overlap but they may contain differing information, so there may be a dissociation between match effects in familiarity- and recollection-related ERP components.

Following from the introductory thoughts, the two ERP retrieval effects should be sensitive to the degree of conscious encoding. In the present study, we led subjects to consciously encode a specific perceptual feature of common objects (their colour). In the subsequent old/new recognition test, we changed either the colour or the presentation size of a subset of old items. One general prediction could then be that the recollection-related ERP old–new effect should be reduced for old items with a changed colour, but nor for old items with a changed size.

Before we concretise this prediction, we will first discuss the role of perceptual features for recognition memory, and explain our general experimental approach to its investigation—the study-test manipulation of sensory features.

1.1. Perceptual features in recognition memory

A typical perceptual study-test manipulation is the manipulation of object colour. Subjects study a list of arbitrarily coloured objects (e.g., a blue[2] car, a red balloon, etc.) and are then tested with a mixed list of old-same, old-different, and new items (e.g., a blue car, a green balloon, and a yellow shirt). They can be instructed to ignore the perceptual features and any changes to them, or they can be asked to accept only exact copy cues as 'old' (i.e., studied) items. As discussed above, standard dual-process theories of recognition memory would predict that retrieval of an episodic detail such as object colour would need to rely on conscious recollection.

In contrast, some recent ERP studies from our lab have demonstrated that familiarity can also contribute to recognition memory for featural detail (Ecker & Zimmer, in press; Ecker, Zimmer, & Groh-Bordin, 2007a, 2007b). To be more precise, the study-test manipulation of perceptual object features such as the object's colour seems to affect familiarity, whereas the manipulation of contextual information such as the background's colour selectively affects recollection. That is, identically repeated old items will elicit larger ERP old–new effects than changed ones, and these perceptual match effects will affect familiarity and recollection components depending on whether the feature is intrinsic to the object or part of the extrinsic context.

We have further claimed that this dissociation is asymmetric insofar as contextual features should under no circumstances directly influence familiarity (see in particular Ecker, Zimmer, Groh-Bordin, & Mecklinger, 2007c), whereas intrinsic object features may potentially affect both familiarity and recollection. The reason for this asymmetry lies in the supposed hierarchic structure of representations, such that the higher-level binding of object and context information includes the lower-level binding of object features,[3] so there could be some redundancy in mnemonic feature representation (cf. Johnson & Chalfonte, 1994; for a somewhat similar proposal of different representational formats, see Buchler, Light, & Reder, in press, and especially Reder et al., 2000).

Concerning the mechanism by which intrinsic object features are integrated with perceptual and spatiotemporal context information at a higher level (an operation probably requiring hippocampal binding; Cansino, Maquet, Dolan, & Rugg, 2002; Daselaar, Fleck, & Cabeza, 2006), we have speculated that verbal predicates, such as "oh, blue is a nice colour for that car", may constitute well-integrated memory entries with high levels of conscious accessibility and may hence play a vital role in the recollection of perceptual object properties (cf. Ecker et al., 2004).

Thus, features can be represented both on a sensory level and a more conceptual verbal level (Engelkamp & Zimmer, 1994; Ikeda & Osaka, 2007; Paivio, 1995, 2007), and this level of representation may well affect the output level at which features affect memory retrieval (i.e., familiarity and/or recollection). Sensory features are part of a visual representation

[1] Concerning the general association of distinct ERP old-new effects and the processes of recollection and familiarity, see Ecker (2007), Friedman and Johnson (2000), or Rugg and Curran (2007) for reviews.

[2] For interpretation of color in Figs. 1 and 5, the reader is referred to the web version of this article.

[3] We have previously used the terms object token and episodic token for the lower-level and higher-level type of representation, respectively (cf. Ecker, 2007; Ecker, Groh-Bordin, & Zimmer, 2004; Ecker et al., 2007a).