Consciousness and Cognition 22 (2013) 875–886

Contents lists available at SciVerse ScienceDirect

Consciousness and Cognition

journal homepage: www.elsevier.com/locate/concog

Conscious recollection and binding among context features

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ARTICLE INFO

Article history:
Received 19 February 2013
Available online 19 June 2013

Keywords:
Conscious recollection
Remember/know
Episodic memory
Source memory
Context binding

ABSTRACT

Recent research suggests that the subjective feeling of conscious recollection is uniquely characterized by joint memory for several context features while merely familiar memories lack this property (Meiser, Sattler, & Weisser, 2008). In the present research we took the novel approach of extending the dual task paradigm to the simultaneous study of subjective retrieval experience (using the remember/know procedure) and joint memory for two orthogonal context features. While dual task load during encoding lead to reductions in the frequency of the subjective experience of conscious recollection and reductions in overall context memory, joint context memory was *not* affected. Furthermore, the relation of higher overall context memory for consciously recollected items than for familiar items was preserved even under dual task load. These results have import implications for theories of long-term feature binding and the processes involved in producing the experience of conscious recollection.

1. Introduction

Episodic memories are defined by the retrieval of contextual details specifying the circumstances under which these events were encoded and the associated subjective experience has been termed conscious recollection. Memories which are accompanied by a mere feeling of familiarity, on the other hand, are not thought to be associated with the retrieval of episodic details (Tulving, 1985). While there is empirical evidence that conscious recollection is indeed associated with better memory for contextual details than is a feeling of familiarity (Dewhurst & Hitch, 1999; Dudukovic & Knowlton, 2006; Meiser & Bröder, 2002; Perfect, Mayes, Downes, & VanEijk, 1996), recent research has demonstrated that conscious recollection is more specifically characterized by joint memory for different context details from the encoding episode (Boywitt & Meiser, 2012a, 2012b; Meiser & Bröder, 2002; Meiser et al., 2008).

These recent studies show a consistent relationship between the subjective retrieval experience (as assessed with the remember/know paradigm; Tulving, 1985) and joint retrieval of the context details such that 'remember' responses were associated with joint memory of the context features whereas 'know' responses were not. The process underlying joint memory of different context features was termed context–context binding (Meiser & Bröder, 2002). As opposed to simple item-context binding, context–context binding may be conceived as a stronger concatenation of the context features in the memory trace, increasing the probability of joint recall of context features (Boywitt & Meiser, 2012a). In line with the conceptualization of episodic memories as integrated representations of the study episode (e.g., Parkin & Walter, 1992; Perfect et al., 1996; Rajaram, 1993; Tulving, 1985) these studies suggest that memories which are experienced as consciously recollected are coherent re-instantiations of the feature configuration at study while memories which feel only familiar lack this property. The present research pursued two interrelated goals. First, we aimed to fill the gap in knowledge of the

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http://dx.doi.org/10.1016/j.concog.2013.05.010

underlying processes involved in creating context–context binding as a correlate of recollective experience. Second, we sought to shed light on the relation of conscious recollection and context memory in general.

2. Mechanisms of context–context binding

Previous research suggests that context–context binding is produced by an encoding process operating in the immediate focus of attention which integrates the features of the episode into a coherent memory representation (Boywitt & Meiser, 2012b; Uncapher, Otten, & Rugg, 2006). Evidence for this view comes from an imaging study indicating that the intra-parietal sulcus, which is thought to be involved in attentionally mediated binding, is especially activated during encoding of items with two independent context features which are later remembered with both context features as opposed to items which are later remembered with only one context feature (Uncapher et al., 2006). Uncapher et al. suggested that allocation of attention to the "object level" increases the likelihood of establishing bound representations. Behavioral studies offer converging evidence that context–context binding is only observed for context features which are in the focus of processing during encoding (Boywitt & Meiser, 2012b). In an incidental learning situation, context–context binding was only observed for stimulus-bound (i.e., intrinsic) context features (i.e., font color) but not for more peripheral (i.e., extrinsic) context features (i.e., color of a frame), which are not in the immediate focus of attentional processing (Ecker, Zimmer, & Groh-Bordin, 2007; Mulligan, 2011). When intrinsic and extrinsic context features were in the focus of processing due to explicit learning instructions, however, context–context binding was observed for both intrinsic and extrinsic context features, suggesting that context–context binding depends on an attentionally mediated encoding mechanism.

Further evidence comes from research on visual short-term memory, suggesting that binding of different perceptual features is mediated by a resource-demanding process (e.g., Brown & Brockmole, 2010; Rensink, 2000; Stefurak & Boynton, 1986; Treisman & Gelade, 1980; Treisman & Schmidt, 1982; Wheeler & Treisman, 2002). To illustrate, in a visual short-term memory task, Wheeler and Treisman (2002) presented participants with multiple objects simultaneously, which differed in location and color. While change detection performance for the independent features was quite good, changes that affected the binding between location and color such as re-arranged pairs of previously presented features were detected at a much lower rate. Additional empirical evidence for a resource-demanding binding process comes from a study in which participants were required to perform a mental arithmetic task during the retention interval between the presentation of colored shapes and the test phase (Stefurak & Boynton, 1986). This manipulation affected the detection of new shape-color pairings while accuracy for the individual features was largely preserved. In a similar vein, Treisman and Schmidt (1982) have shown that the rate of conjunction errors (i.e., false recognition of re-arranged features from different objects) increased under cognitive load during presentation of the stimuli. Similarly, another study found verbal–spatial binding to be impaired by a concurrent working memory load during stimulus presentation (Elsley & Parmentier, 2009), indicating that the integration of multiple features relies on a resource-demanding process.

Although there is ample evidence that feature binding may rely on resource-demanding processes, there is also evidence suggesting that binding of different features might not be resource-demanding over and above the demands of encoding and maintaining the individual features (e.g., Allen, Baddeley, & Hitch, 2006; Delvenne, Cleeremans, & Laloyaux, 2010; Luck & Vogel, 1997). Allen et al. (2006), for example, did not find decreased recognition performance in a short-term memory task for combinations of features under additional load as compared with the features alone.

3. Goals of the present research

Because previous research has provided only indirect evidence on the attentional demands of context–context binding, we tested the prediction that binding of context features depends on resource-demanding processes (Boywitt & Meiser, 2012a, 2012b; Uncapher et al., 2006) directly by implementing a dual-task manipulation. For that purpose, we employed a multidimensional source memory paradigm with two completely crossed context dimensions (Meiser & Bröder, 2002) and assessed subjective retrieval experience with the remember/know-procedure. In the multidimensional source memory paradigm participants study items varying on two orthogonal context dimensions, for example items presented at two different screen positions and two different font sizes. Assessing memory for two completely crossed context dimensions allows for the analysis of stochastic dependence in context memory. For instance, if retrieving one context feature (e.g., font size) is more likely if the other context feature (e.g., screen position) is also retrieved compared with retrieving the feature font size alone, then context memory is stochastically dependent. The phenomenon of stochastic dependence in memory for context features has been taken as an indication of context–context binding.

Theoretically, stochastic dependency in memory for two orthogonal context features is independent from "simple" memory for each context feature. That is, memory could be fairly accurate for both context features but may still be stochastically independent (cf. Light & Berger, 1976). Indeed, this pattern of results has been observed when "simple" context memory was experimentally equated between *R* and *K* judgments but stochastic dependency was still only observed for *R* responses, suggesting a qualitative difference in the underlying memory characteristics of *R* and *K* responses (Meiser et al., 2008).

In the first experiment stochastic dependency in context memory as an indication of context binding was compared between a condition with dual task (DT) load during study and a full attention condition. In the second experiment we broadened our focus to include the relation of subjective retrieval experience and context memory in general.