



## Emotion impairs extrinsic source memory—An ERP study

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### ABSTRACT

Substantial advancements in understanding emotional modulation of item memory notwithstanding, controversies remain as to how emotion influences source memory. Using an emotional extrinsic source memory paradigm combined with remember/know judgments and two key event-related potentials (ERPs)—the FN400 (a frontal potential at 300–500 ms related to *familiarity*) and the LPC (a later parietal potential at 500–700 ms related to *recollection*), our research investigated the impact of emotion on extrinsic source memory and the underlying processes. We varied a semantic prompt (either “people” or “scene”) preceding a study item to manipulate the extrinsic source. Behavioral data indicated a significant effect of emotion on “remember” responses to extrinsic source details, suggesting impaired recollection-based source memory in emotional (both positive and negative) relative to neutral conditions. In parallel, differential FN400 and LPC amplitudes (correctly remembered – incorrectly remembered sources) revealed emotion-related interference, suggesting impaired familiarity and recollection memory of extrinsic sources associated with positive or negative items. These findings thus lend support to the notion of emotion-induced memory trade off: while enhancing memory of central items and intrinsic/integral source details, emotion nevertheless disrupts memory of peripheral contextual details, potentially impairing both familiarity and recollection. Importantly, that positive and negative items result in comparable memory impairment suggests that arousal (vs. affective valence) plays a critical role in modulating dynamic interactions among automatic and elaborate processes involved in memory.

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### 1. Introduction

Emotionally charged events—weddings, graduation ceremonies or painful breakups—are often remembered vividly after a long time. However, certain details (e.g., color of the napkin at the reception) of such emotional episodes can fade quickly or be remembered mistakenly. Distinctions have been drawn between memory for central items of an event (i.e., *item memory*) and memory for contextual details of the event (i.e., *source memory*). While convergent evidence indicates that emotion enhances item memory (Christianson, 1992; Hamann, 2001; Neisser & Libby, 2000), controversies arise concerning whether source memory could be similarly enhanced (Cook, Hicks, & Marsh, 2007; D’Argembeau

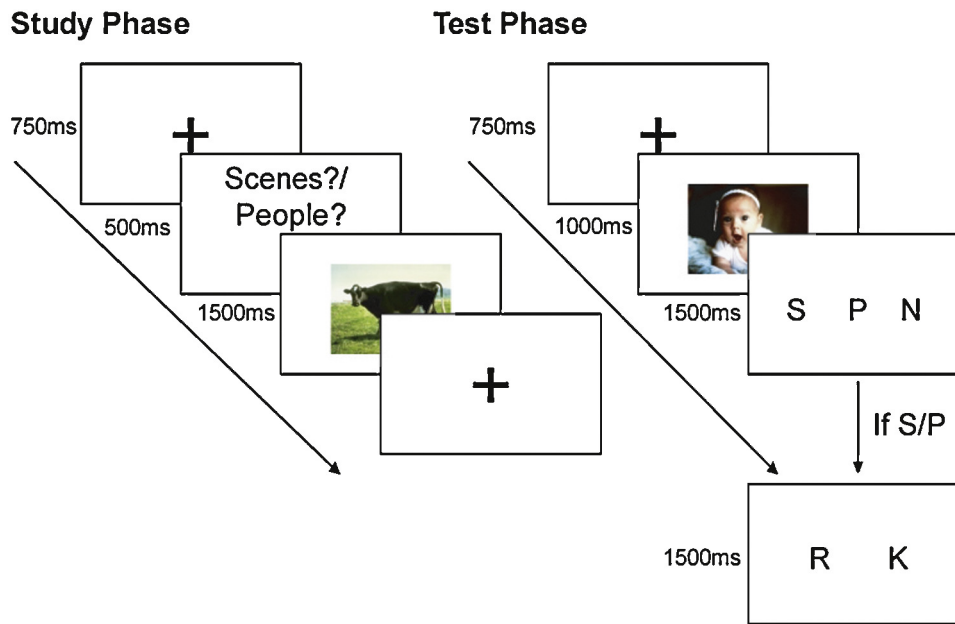
& Van der Linden, 2004; Madan, Caplan, Lau, & Fujiwara, 2012). Some researchers propose that emotion enhances source memory by increasing overall attention and prioritizing binding of emotional items to their contexts (Hadley & MacKay, 2006; Revelle & Loftus, 1992). However, others suggest attentional trade-off between central emotional items and peripheral contextual details (Easterbrook, 1959; Laney, Campbell, Heuer, & Reisberg, 2004), which could compromise memory encoding and binding in emotional situations (Payne, Nadel, Britton, & Jacobs, 2004; Waring & Kensinger, 2011), resulting in impaired source memory.

Nevertheless, this controversy may be reconciled when the type of source details involved (i.e., *intrinsic* vs. *extrinsic*) is taken into account. Intrinsic source details refer to features that are integral parts of an item (i.e., *within-item* features), such as perceptual properties (e.g., shape of a car; color of a phone). Extrinsic source details consist largely of *external* features, involving between-item associations (e.g., the context in which the car or phone was seen). It is proposed that emotion boosts intrinsic (but not extrinsic) source memory by facilitating encoding and information binding of intrinsic source details (Hadley & MacKay, 2006; Kensinger, 2007, 2009; Mather, 2007; Revelle & Loftus, 1992); and indeed, evidence

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**Fig. 1.** Experimental paradigm.

In an emotional extrinsic source memory task, participants completed a study phase immediately followed by a test phase. During the study phase, participants were instructed to make yes/no response to indicate whether the image contained content consistent with the prompt (a scene or people) and to remember both the image and the extrinsic source (the prompt). During the test phase, participants were asked to make a response of scene (S), people (P) or new (N). With an S/P response, participants were asked further to indicate whether they remembered (R) or knew (K) the source.

has accrued in support of emotion-induced memory enhancement for intrinsic source details (D'Argembeau & Van der Linden, 2004; Kensinger & Corkin, 2003; Mather & Nesmith, 2008), while showing no or impairing effects of emotion on extrinsic source details (Cook et al., 2007; Davidson, McFarland, & Glisky, 2006; Kesinger & Schacter, 2006; Madan et al., 2012). Therefore, emotion can shift source memories in opposing directions (improving intrinsic and impairing extrinsic source memory), accounting for the seemingly controversial findings in the literature.

Compromised source memory of extrinsic details under emotional or stressful situations (Payne et al., 2004) can have significant real life implications. For instance, crime eyewitness testimonies concerning extrinsic contextual details are often inaccurate and unreliable (Christianson & Loftus, 1991; Loftus, 1979), causing serious or even tragic problems in the court. Nevertheless, studies that systematically investigate extrinsic source memory of emotional events are scarce, and so remain unclear the psychological processes and neural mechanisms underlying emotional modulation of extrinsic source memory.

Therefore, we examined emotional modulation of extrinsic source memory using a modified extrinsic source memory task (Mollison & Curran, 2012) along with scalp electrophysiological recording. In particular, we assessed how emotion interacts with two key processes involved in recognition memory—familiarity (a fast and automatic process underpinning a general feeling of prior occurrence) and recollection (a slower process supporting conscious retrieval of specific episodic details; Yonelinas, 2002). Recollection and familiarity processes were measured using well-established remember/know (R/K) judgments, respectively, (Duarte, Ranganath, Winward, Hayward, & Knight, 2004; Mollison & Curran, 2012; Vilberg, Moosavi, & Rugg, 2006) in combination with two important event-related potential (ERP) correlates. The FN400 (a positive shift or reduction in negativity in frontal regions around 400 ms) was used to index familiarity, and the late positive complex (LPC; a positive component over posterior regions at a later window) to index recollection (Curran, 2000; Diana, Yonelinas, & Ranganath, 2007; Rugg & Curran, 2007). Briefly, at

study, a picture (study item containing positive, negative or neutral emotion) was presented after a semantic prompt (“scene” or “people”, serving as extrinsic source), and at test, participants made “scene”, “people” or “new” responses to test items, followed by R/K judgments.

To the extent that recognition of source details (i.e., source memory) is a defining feature of recollection, recent evidence suggests that familiarity can also contribute to source memory (Addante, Ranganath, & Yonelinas, 2012; Bastin, Van der Linden, Schnakers, Montaldi, & Mayes, 2010; Cansino, Maquet, Dolan, & Rugg, 2002; Diana, Yonelinas, & Ranganath, 2008; Mayes, Montaldi, & Migo, 2007; Speer & Curran, 2007; Zimmer & Ecker, 2010). While most of this work concerns intrinsic source memory, behavioral and ERP evidence also exists in support of familiarity in extrinsic source memory (Mollison & Curran, 2012; Peters, Daum, Gizewski, Forsting, & Suchan, 2009; Speer & Curran, 2007, but also see Ecker, Zimmer, & Groh-Bordin, 2007). We thus interrogated the possibility that emotional items would interfere with familiarity and recollection in extrinsic source memory, resulting in reduced source accuracy and diminished source-correct (vs. -incorrect) ERP amplitudes.

## 2. Material and methods

### 2.1. Participants

Twenty right-handed college students from Capital Normal University (Beijing, China) with normal or corrected-to-normal vision participated in the experiment and received monetary compensation. Participants denied a history of psychiatric or neurological disorders, head injury, or psychotropic drug use. Data from three participants were excluded due to poor performance (i.e., minimal correct ERP trials <20), excessive eye movements or EEG artifacts (e.g., alpha), resulting in a final sample of 17 participants (mean age, 23.4 years; 7 men). All participants provided informed consent to participate in this study, which was approved by the Capital Normal University Human Research Committee.

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