Consciousness and Cognition 53 (2017) 1–13

Contents lists available at ScienceDirect

Consciousness and Cognition

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

Electrophysiological signals associated with fluency of different levels of processing reveal multiple contributions to recognition memory

Bingbing Li[a,b], Jason R. Taylor[d,*], Wei Wang[b,e], Chuanji Gao[b,f], Chunyan Guo[b,c,*]

[a] School of Education Science, Jiangsu Normal University, Xuzhou 221116, PR China
[b] Beijing Key Laboratory of Learning and Cognition, Department of Psychology, Capital Normal University, Beijing 100048, PR China
[c] Beijing Advanced Innovation Center for Imaging Technology, Capital Normal University, Beijing 100048, PR China
[d] Division of Neuroscience and Experimental Psychology, School of Biological Sciences, Faculty of Biology, Medicine, and Health, University of Manchester, Manchester Academic Health Science Centre, Manchester, United Kingdom
[e] MOE Key Laboratory of Modern Teaching Technology, Shaanxi Normal University, Xi'an 710062, PR China
[f] Department of Psychology, Institute of Mind and Brain, University of South Carolina, Columbia 29201, SC, USA

ARTICLE INFO

Keywords:
Repetition priming
Conceptual priming
Fluency
Familiarity
Recollection

ABSTRACT

Processing fluency appears to influence recognition memory judgements, and the manipulation of fluency, if misattributed to an effect of prior exposure, can result in illusory memory. Although it is well established that fluency induced by masked repetition priming leads to increased familiarity, manipulations of conceptual fluency have produced conflicting results, variously affecting familiarity or recollection. Some recent studies have found that masked conceptual priming increases correct recollection (Taylor & Henson, 2012), and the magnitude of this behavioural effect correlates with analogous fMRI BOLD priming effects in brain regions associated with recollection (Taylor, Buratto, & Henson, 2013). However, the neural correlates and time-courses of masked repetition and conceptual priming were not compared directly in previous studies. The present study used event-related potentials (ERPs) to identify and compare the electrophysiological correlates of masked repetition and conceptual priming and investigate how they contribute to recognition memory. Behavioural results were consistent with previous studies: Repetition primes increased familiarity, whereas conceptual primes increased correct recollection. Masked repetition and conceptual priming also decreased the latency of late parietal component (LPC). Masked repetition priming was associated with an early P200 effect and a later parietal maximum N400 effect, whereas masked conceptual priming was only associated with a central-parietal maximum N400 effect. In addition, the topographic distributions of the N400 repetition priming and conceptual priming effects were different. These results suggest that fluency at different levels of processing is associated with different ERP components, and contributes differentially to subjective recognition memory experiences.

* Corresponding authors at: Division of Neuroscience and Experimental Psychology, University of Manchester, Zochonis Building, Brunswick Street, Manchester M13 9PL, United Kingdom (J.R. Taylor). Beijing Key Laboratory of Learning and Cognition, Department of Psychology, Capital Normal University, Beijing 100048, PR China (C. Guo).

E-mail addresses: jason.taylor@manchester.ac.uk (J.R. Taylor), guocy@cnu.edu.cn (C. Guo).

http://dx.doi.org/10.1016/j.concog.2017.05.001
Received 5 November 2016; Received in revised form 8 April 2017; Accepted 8 May 2017

1. Introduction

Processing fluency, which refers to the subjective experience of ease or difficulty with cognitive processing, has a profound influence on people's behaviour (for review see Oppenheimer, 2008). In the memory research literature, numerous studies have found that participants are more likely to endorse fluently processed items to be old regardless of whether those items have indeed been seen previously (e.g., Jacoby & Whitehouse, 1989; Rajaram, 1993; Woollams, Taylor, Karayanidis, & Henson, 2008). In one pioneering study, Jacoby and Whitehouse (1989) preceded recognition memory test words with a brief, masked prime word that was either the same word (matched) or unrelated to the test word (non-matched). They found that subjects endorsed more test words as old if they were preceded by matched primes relative to non-matched primes, regardless of the study status of the test words. This effect occurred even though participants were unaware of the presentation of the prime word; indeed, the effect disappeared when primes were presented for a longer duration, making participants aware of their presence.

Jacoby and Whitehouse (1989) interpreted their findings as due to *perceptual* fluency being misattributed to *familiarity*; however, neither the level of processing fluency nor the nature of the memory process was investigated directly in their study. According to dual-process models, recognition memory is supported by two distinct processes: familiarity and recollection. Recollection refers to the recognition experience accompanied by recall of context or other relevant information associated with the prior event, whereas familiarity is the recognition experience without any such recall (Mandler, 1980; Yonelinas, 2002). Subsequent studies using the Jacoby and Whitehouse paradigm combined with remember/know (R/K) procedure (Tulving, 1985; for review see Migo, Mayes, & Montaldi, 2012) found that the fluency manipulation increased familiarity (K responses) only, and had no effect on recollection (R responses; e.g., Kinoshita, 1997; Kurilla, 2011; Rajaram, 1993; Woollams et al., 2008). A further study investigated whether fluency at a higher, *conceptual*, level of processing could also be misattributed to familiarity. In that study, conceptual primes (semantically related and lexically associated, according to word-association norms) were presented prior to recognition memory test cues in an R/K paradigm (Rajaram & Geraci, 2000). Rajaram and Geraci (2000) found that conceptual fluency also only affected K responses, suggesting that fluency at both perceptual and conceptual levels can influence the feeling of familiarity.

Recently, however, several studies found that masked conceptual priming of test cues increases recollection rather than familiarity (hits only, not false alarms; Taylor, Buratto, & Henson, 2013; Taylor & Henson, 2012). These studies used primes that were conceptually related but *not* lexically associated to recognition memory test words (e.g., piano-GUITAR) in some blocks, and repetition primes (e.g., guitar-GUITAR) in separate blocks. Consistent with prior studies, repetition primes selectively increased familiarity (K hits and K false alarms); however, in contrast to Rajaram and Geraci (2000), conceptual primes selectively increased correct recollection (R hits), and had no effect on either K responses or R false alarms.

One possible explanation for the discrepancy between these studies is that lexically associated primes may increase fluency at an earlier, lexical stage of processing rather than the conceptual level (Lucas, 2000; Taylor & Henson, 2012). The very definition of lexical association—that given the cue word, the target will be come to mind with high probability—makes it likely that a representation of the primed test word would already have come to mind before the test word was itself presented, and this scenario bears more similarity to repetition priming than to conceptual priming. In contrast, Taylor and Henson (2012)'s conceptual prime-target pairs were semantically related but not lexically associated; therefore, the increase in correct recollection found in that study must have been an effect of conceptual-level rather than earlier, lexical-level processing.

To explain the effect of conceptual priming on R hits, Taylor and Henson (2012) suggested that conceptual primes automatically activate concepts that are related to both the prime and test word, which participants might have spontaneously generated upon seeing the test word in the study phase. Thus, conceptual primes increase the fluency with which participants re-retrieve information about the test cue which they had generated in the study phase, which in turn makes successful recollection (and correct R responses) more likely. This 'true' recollection account is supported by the finding that, in an fMRI study, the magnitude of the behavioural conceptual priming effect was positively correlated with the magnitude of the BOLD conceptual priming effect in brain regions associated with recollection (Taylor et al., 2013).

This notion—that fluency at early stages of item processing leads to familiarity, whereas fluency of conceptual activation leads to recollection—is consistent with the extant data, but has not yet been tested directly. In Taylor et al.'s (2013) fMRI study, neither repetition nor conceptual priming produced effects that survived correction for multiple comparisons across the whole brain, likely owing to the relatively insensitivity of the BOLD signal to transient effects like very briefly presented masked primes. Therefore, a comparison between neural correlates of these priming effects could not be tested directly. In the present study, we use event-related potentials (ERP) to investigate the neural bases of these fluency effects and their contributions to recognition memory.

ERPs have been widely used to investigate the neural correlates of masked priming effects, mainly using indirect tasks such as lexical decision. Masked repetition priming has been found to be related to a relatively early effect around the latency of P200, and a later effect around the latency of N400 (e.g., Holcomb & Grainger, 2006; Misra & Holcomb, 2003). The early P200 may reflect initial phase of sub-lexical orthographic processing and the N400 may reflect processing at form–meaning interface stage (Holcomb & Grainger, 2006). Masked semantic (conceptual) priming also produces N400 priming effects (Deacon, Hewitt, Yang, & Nagata, 2000; Kiefer, 2002; Kiefer & Brendel, 2006) similar to semantic congruency effects found in sentence processing (e.g., Kutas & Hillyard, 1980), although priming effects appear to be less robust (see, e.g., Brown & Hagoort, 1993 for null effects). The N400 conceptual priming effect may reflect automatic spreading of conceptual representation of the prime (Kiefer, 2002).

In the field of recognition memory, it is generally accepted that spatio-temporally different ERPs, the FN400 and LPC (late parietal component), are associated with familiarity and recollection, respectively (e.g., Curran, 2000; Rugg et al., 1998; for review see Rugg & Curran, 2007). The FN400 is a fronto-centrally distributed old-new effect that occurs between 300–500 ms after the presentation of a memory test cue, which does not differentiate between recollected and familiar items, and has therefore been