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Testing the context-change account of list-method directed forgetting: The role of retention interval

Magdalena Abel *, Karl-Heinz T. Bäuml

Department of Experimental Psychology, Regensburg University, Germany

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ABSTRACT

People can voluntarily forget previously studied material when cued to do so. Such directed forgetting may arise because the forget cue induces a change in mental context, thus causing context-dependent forgetting. This context-change account predicts that both context-dependent forgetting and directed forgetting should be relatively transient and be reduced, if not eliminated, after prolonged retention interval. In each of two experiments, participants studied two lists of items and between study of the lists were asked to remember or forget the first list, or engage in an imagination task. After a short or a prolonged retention interval recall of the first list items was tested. Whereas imagination induced forgetting that was restricted to short retention intervals, the forget cue induced forgetting that was present regardless of retention interval. The finding challenges the context-change account and indicates that the effects of a forget cue and induced mental context change can be nonequivalent.

Introduction

At least to some degree, humans can control the contents of their minds and, for instance, voluntarily forget stored memory contents (for a review, see Anderson & Hanslmayr, 2014). One of the tasks developed to investigate voluntary forgetting experimentally is list-method directed forgetting (LMDF; Bjork, 1970). In this task, subjects study two lists of items and, between study of the two lists, are asked to remember or to forget the first list. At test, participants' memory for list-1 items is tested irrespective of original cuing. The typical result in this task is that forget-cued participants recall fewer first list items than remember-cued participants, which is referred to as list-1 forgetting. The finding is not a mere effect of demand characteristics, because the forgetting occurs even when participants are offered money for each single recalled item (MacLeod, 1999). It arises over a wide range of study materials, including verbal material (Geiselman, Bjork, & Fishman, 1983), pictures (Basden & Basden, 1996), autobiographical memories (Barnier et al., 2007), and even habits (Dreisbach & Bäuml, 2014), and a wide range of experimental settings (for reviews, see Bäuml, Pastötter, & Hanslmayr, 2010; MacLeod, 1998; Sahakyan, Delaney, Foster, & Abushanab, 2013).

Since the finding was first reported, several accounts have been suggested to explain the forgetting arising in LMDF. Currently, primarily two accounts are discussed in the literature, the one being the inhibition account and the other the (non-inhibitory) context-change account. The inhibition account assumes that forget-cued participants engage in inhibitory control processes on the list-1 items, which, at test, impair access to list 1 and thereby reduce recall of the first list items (Geiselman et al., 1983). In contrast, the context-change account assumes that, in response to the forget cue, participants deliberately change mental context, so that the context at test no longer

* Corresponding author at: Department of Experimental Psychology, Regensburg University, 93040 Regensburg, Germany. Fax: +49 941 943 3872.
E-mail address: magdalena.abel@ur.de (M. Abel).

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matches the context during list-1 study and recall of the first list items is impaired (Sahakyan & Kelley, 2002; for further accounts of LMDF, see MacLeod, 1998, and General Discussion below).

Distinguishing between the context-change and the inhibition account of LMDF

Over the years, a number of findings have been interpreted as specific support for each of the single accounts. For instance, the finding that divided attention during list-2 encoding can reduce or even eliminate list-1 forgetting has been regarded as evidence for an inhibitory control process that is active during list-2 encoding and requires cognitive resources to reduce interference from list-1 items (Conway, Harries, Noyes, Racsmany, & Frankish, 2000; Macrae, Bodenhausen, Milne, & Ford, 1997). Similarly, the report of a causal relationship between neural activity in the dorsolateral prefrontal cortex during list-2 encoding and the forgetting of list-1 items has been interpreted as being indicative for inhibitory action (Hanslmayr et al., 2012). In contrast, the finding that list-1 forgetting is typically absent in item recognition (e.g., Geiselman et al., 1983) but can be present on recognition tests that require greater reliance on contextual information (Sahakyan, Waldum, Benjamin, & Bickett, 2009) has been regarded as evidence for the context-change account, just like the finding of the elimination of the forgetting when categorized lists are studied and the category names of the studied items are presented as retrieval cues at test (Lehman & Malmberg, 2011). Although all of these findings may be interpreted in favor of the one account over the other, it is not always clear whether they can really provide such specific support (see also Sahakyan et al., 2013).

The question of whether the prior work demonstrated specific evidence for one of the two accounts of LMDF directly relates to the more basic question of whether the forgetting that arises in response to a forget cue in LMDF differs from the forgetting that, in a context-change paradigm, may arise when between study of two lists a change in participants' mental context is induced, for instance, by asking the participants to mentally walk through the house of their parents or describe what they would like to do if they were invisible (e.g., Jonker, Seli, & MacLeod, 2013; Pastötter & Bäuml, 2007; Sahakyan & Kelley, 2002). On the basis of the context-change account, which assumes that both forms of forgetting are mediated by mental context change, the two forms of recall impairment should not be different and no factors should exist that influence the one form of forgetting (e.g., directed forgetting) but not the other (e.g., context-dependent forgetting).

In recent years, several studies directly compared the effects of a forget cue and induced mental context change, reporting largely parallel effects. For instance, Sahakyan and Kelley (2002) reported that context reinstatement procedures at test can reduce the forgetting induced by a forget cue as well as the forgetting induced by mental context change. Bäuml and Samenieh (2012b) found preceding selective retrieval of some first-list items to reduce the forgetting of the remaining list items, both after a forget cue and induced context change. Furthermore, the two forms of forgetting have been found to be accompanied by similar serial-position curves for list-1 items (Sahakyan & Foster, 2009), depend both on working memory capacity (Delaney & Sahakyan, 2007), and emerge in the presence, but not the absence of list-2 encoding (Pastötter & Bäuml, 2007).

Indeed, to date only few studies point to possible experimental dissociations between the two forms of forgetting. One such dissociation may be a difference in neural activity arising in the two experimental situations. Employing the standard two-list task, Bäuml, Hanslmayr, Pastötter, and Klimesch (2008) and Pastötter, Bäuml, and Hanslmayr (2008) examined physiological activities after a forget cue versus induced mental context change by measuring electroencephalograms during list-2 encoding and analyzing subjects' oscillatory brain activity. They found the forgetting of list-1 items in LMDF to be reflected by a sustained decrease in phase synchronization in a certain frequency band (11–13 Hz), but found no evidence for such a decrease when the forgetting was induced by mental context change. Because phase synchronization between electrode sites is regarded a measure of the synchrony between distant neural assemblies (e.g., Lachaux, Rodriguez, Martinerie, & Varela, 1999) and coherent firing between distant neuronal populations has been regarded a mechanism subserving binding processes (e.g., Miltner, Braun, Arnold, Witte, & Taub, 1999), the decrease in phase synchronization could reflect the unbinding of list-1 items and the inhibitory deactivation of the retrieval routes to list-1 items (see also Hanslmayr et al., 2012). The reported difference in neural activity in the two situations thus may indicate that the effects of a forget cue and induced mental context change are indeed dissociable, at least neurally. Behaviorally, no clearcut evidence for a dissociation has arisen to date.

The possible role of retention interval to distinguish between context-dependent forgetting and directed forgetting

A particularly interesting factor to examine whether the effects of a forget cue and induced mental context change are behaviorally dissociable may be the retention interval between study and test. According to the context-change account of LMDF, which assumes that the forget cue creates mental context change, both context-dependent forgetting and directed forgetting should be reduced, if not eliminated, after prolonged retention interval (e.g., Sahakyan & Kelley, 2002). Mental context is known to fluctuate over time (e.g., Estes, 1955; McGeoch, 1932) and induction of a change in mental context between study of two lists will enhance such contextual fluctuation, causing the two lists to have a greater contextual disparity than in the absence of such change and impairing recall of the first list items, at least when testing occurs shortly after study. Importantly, however, because a prolonged retention interval between study and test will change the context sufficiently far away from the list contexts, the difference between the two list contexts may become relatively small with increasing retention interval and recall of the first list items will no longer depend much on the originally induced mental context change, i.e., the