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Does an instruction to forget enhance memory for other presented items?

Tracy L. Taylor *, Jonathan M. Fawcett

Dalhousie University, Department of Psychology and Neuroscience, 1355 Oxford Street, PO Box 5000, Halifax Nova Scotia, Canada B3H 4R2

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ABSTRACT

In an item-method directed forgetting paradigm, participants were required to attend to one of two colored words presented on opposite sides of a central fixation stimulus; they were instructed to *Remember* or *Forget* the attended item. On a subsequent recognition test, the *Attended* words showed a typical directed forgetting effect with better recognition of *Remember* words than *Forget* words. Our interest was in the fate of the *Unattended* words. When the study display disappeared before the memory instruction, there was no effect of that instruction on unattended words; when the study display remained visible during presentation of the memory instruction, there was a reverse directed forgetting effect with better recognition of unattended words from *Forget* trials than from *Remember* trials. Incidental encoding of task-irrelevant stimuli occurs following presentation of a *Forget* instruction – but only when those task-irrelevant stimuli are still visible in the external environment.

1. Introduction

Intentionally forgetting unwanted information serves memory by enabling the redistribution of limited capacity cognitive resources (e.g., Taylor, 2005a, 2005b; Taylor & Fawcett, 2011). In the laboratory, intentional forgetting is often studied using a directed forgetting paradigm (see Basden & Basden, 1998). In the item-method version of this paradigm, words are presented one at a time during study, each accompanied or followed by an instruction to *Remember* or *Forget*. A typical finding is that more *Remember* items are correctly recognized than *Forget* items (for a review, see MacLeod, 1998). This directed forgetting effect is not attributable to demand characteristics (MacLeod, 1999) and – at least when tested with recall – is presumed to result from a combination of benefits for performance in the *Remember* condition and costs in the *Forget* condition, relative to when participants must commit all items to memory (Sahakyan & Foster, 2009).

When a directed forgetting effect is obtained in an item-method paradigm, it is typically attributed to processes occurring at encoding rather than at retrieval (Basden, Basden, & Gargano, 1993; Bjork, 1972; although see, Nowicka, Jednoróg, Marchewka, & Brechmann, 2009; Ullsperger, Mecklinger, & Müller, 2000). The most common conceptualization is that the difference in memory performance for *Remember* and *Forget* items is due to differential rehearsal. When the study word is presented on each trial, participants attend to the word and maintain its representation in working memory until they receive a memory instruction. If the instruction is to *Remember* the word, the participant engages in elaborative rehearsal to commit that item to memory; if the instruction is to *Forget*, the participant drops this now-irrelevant item from the rehearsal set and allows its representation to decay.

A question that has been of interest to our laboratory is how the *Forget* item is dropped from the rehearsal set. One possibility is that forgetting involves the passive decay of an unrehearsed memory trace. An alternative possibility is that the intention to *Forget* engages an active cognitive mechanism that limits further *Forget* item processing and commitment to memory.

* Corresponding author. Fax: +1 902 494 6585.
E-mail addresses: ttaylor2@dal.ca (T.L. Taylor), jmfawcet@dal.ca (J.M. Fawcett).

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Distinguishing between these two accounts requires an assessment of the relative cognitive load associated with instantiating a *Forget* versus a *Remember* instruction. On the one hand, if a *Forget* instruction leads to passive decay of the to-be-forgotten item, instantiating a *Forget* instruction should be relatively less effortful than instantiating a *Remember* instruction. On the other hand, if a *Forget* instruction requires an active withdrawal of processing resources from the to-be-forgotten item, the effort associated with instantiating a *Forget* instruction should be fairly similar to that associated with instantiating a *Remember* instruction (which requires the active commitment of processing resources). Where reaction times (RTs) to detect a visual probe provide a proxy measure of cognitive load (see Kahneman, 1973), Fawcett and Taylor (2008, 2010) demonstrated that instantiating a *Forget* instruction is not only effortful, in the first ~1.5–2 s it is actually *more* effortful than instantiating a *Remember* instruction. This was revealed by a pattern of longer probe RTs following *Forget* than following *Remember* instructions. Interestingly, when the probe task was changed to require a speeded color discrimination of an otherwise task-irrelevant probe word written in blue or pink font, RTs continued to be longer following *Forget* than following *Remember* instructions, whereas incidental memory formation for the probe words was better following *Remember* than following *Forget* items (Fawcett & Taylor, 2012). Taken together, these findings suggest that instantiating a *Forget* instruction is more effortful than instantiating a *Remember* instruction with consequences for subsequent incidental memory formation.

Critically, longer probe RTs in the first seconds following a *Forget* than following a *Remember* instruction are not attributable to the retrieval and cumulative rehearsal of to-be-remembered items from preceding trials (for discussion, see Fawcett & Taylor, 2008, 2010). Probe RTs are longer following *Forget* than following *Remember* instructions even on the very first study trial (see Fawcett, Taylor, & Nadel, submitted for publication) – that is, even when there are no items to retrieve and rehearse from preceding trials. Probe RTs are also longer on *Forget* trials than on interleaved no-word control trials for which retrieval and cumulative rehearsal of to-be-remembered items from preceding trials would also be expected to occur (Fawcett & Taylor, 2008). Thus, while it is likely that participants do ultimately use the inter-trial interval to cumulatively rehearse *Remember* items from preceding trials, retrieval and cumulative rehearsal of items from preceding *Remember* trials cannot fully account for the greater initial effort associated with instantiating a *Forget* versus *Remember* instruction. Intentional forgetting is not simply a failure to encode the passively decaying *Forget* item during the retrieval and cumulative rehearsal of preceding *Remember* items.

That intentional forgetting involves more than a failure to encode the to-be-forgotten items is confirmed by event-related functional magnetic resonance imaging (fMRI), which shows unique activations in hippocampus and superior frontal gyrus during the study of words that are subsequently forgotten intentionally versus those that are forgotten unintentionally (Wylie, Foxe, & Taylor, 2008). Notably, the successful versus unsuccessful instantiation of a memory intention also activates brain regions critically involved in attentional control networks (Wylie et al., 2008; *cf.* Fan, McCandliss, Fossella, Fombaum, & Posner, 2005). This implicates attentional control not only in the successful instantiation of an intention to *Remember* but also in the successful instantiation of an intention to *Forget*.

Where the mental representation of a *Forget* item includes its spatial location in the case of words presented in the visual periphery (e.g., Hourihan, Goldberg, & Taylor, 2007), behavioral data suggest that instantiating an intention to *Forget* initiates an effortful withdrawal of attention from the representation of the *Forget* item (Taylor, 2005a). This conclusion follows from a paradigm in which words are presented to the left and right during the study phase of an item-method task. Following the disappearance of each word, a tone instructs participants to *Remember* or *Forget*. Then, a visual target requiring a localization response is presented in the same location as the preceding word or in a different location. The dependent measure of interest is the RT to localize the target to the same versus a different location as the word, as a function of memory instruction. This provides a measure of the inhibition of return (IOR) effect on *Remember* and *Forget* trials.

In a typical IOR task, the initial peripheral onset is a visual stimulus such as an asterisk or a brightening of a box at the peripheral location; there is no word and no requirement to commit anything to memory. In such a task, the typical finding is that RTs are slower for targets that appear in the same location as the preceding peripheral visual onset than in a different location (Posner & Cohen, 1984). This pattern is referred to as an IOR effect. This effect is generated automatically by the onset of the initial peripheral stimulus; however, because the IOR effect can co-occur with, and thereby be obscured by, an opposing facilitatory effect due to the initial capture of attention by the peripheral onset (e.g., Dorris, Klein, Everling, & Munoz, 2002; Ro & Rafal, 1999; Tipper et al., 1997; see Klein, 2000 and Taylor & Klein, 1998 for reviews), the IOR effect does not become apparent in RTs until "unmasked" by the withdrawal of attention from the peripheral location (cf. Danziger & Kingstone, 1999). In this way, the IOR effect can serve as an index of attentional withdrawal.

When the IOR effect is measured within the context of the study trials of an item-method directed forgetting paradigm, the magnitude of this effect is consistently larger following *Forget* than following *Remember* instructions. Because the IOR effect becomes measurable in RTs as attention withdraws from the peripheral location, this *Forget* > *Remember* IOR difference is consistent with a more ready withdrawal of attention following *Forget* than following *Remember* instructions (Fawcett & Taylor, 2010; Taylor, 2005a; Taylor & Fawcett, 2011). While there is some indication that this *Forget* > *Remember* IOR difference may be due to a tendency for attention to dwell on the *Remember* item representation as well as a tendency for attention to withdraw from the *Forget* item representation, the withdrawal of attention on *Forget* trials is the more robust and consistent finding (e.g., Taylor, 2005a) and occurs across a wide range of word-instruction and instruction-target stimulus onset asynchronies (with no indication that a withdrawal of attention is simply slower to occur following a *Remember* instruction; see Taylor & Fawcett, 2011).

Given that an instruction to *Forget* initiates a withdrawal of attention from the representation of the *Forget* word we are left to wonder – where does attention go? In the case of a peripherally presented *Forget* word, is visuo-spatial attention