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Motivated forgetting reduces veridical memories but slightly increases false memories in both young and healthy older people

Alfonso Pitarque[a,*], Encarnación Satorres[b], Joaquín Escudero[c], Salvador Algarabel[a], Omar Bekkers[d], Juan C. Meléndez[b]

[a] Dept. Methodology, Faculty of Psychology, University of Valencia, Av. Blasco Ibanez 21, 46010 Valencia, Spain
[b] Dept. Developmental Psychology, Faculty of Psychology, University of Valencia, Av. Blasco Ibanez 21, 46010 Valencia, Spain
[c] Dept. Neurology, General Hospital, Av. Tres Cruces 2, 46014 Valencia, Spain
[d] Faculty of Psychology, University of Valencia, Av. Blasco Ibanez 21, 46010 Valencia, Spain

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ABSTRACT

The aim of the current study is to examine the effects of motivated forgetting and aging on true and false memory. Sixty young and 54 healthy older adults were instructed to study two lists of 18 words each. Each list was composed of three sets of six words associated with three non-presented critical words. After studying list 1, half of the participants received the instruction to *forget* List 1, whereas the other half received the instruction to *remember* List 1. Next, all the subjects studied list 2; finally, they were asked to remember the words studied in both lists. The results showed that when participants intended to forget the studied List 1, they were less likely to recall the studied words, but more likely to intrude the critical words. That is, we can intentionally forget something but this can also entail the intrusion of some related false memories.

1. Introduction

At certain times, we would all like to intentionally forget some memories, especially those that are disagreeable to us (e.g., an accident, an aggression, an illness, etc.). Experimental research has shown that suppressing the awareness of a memory can be achieved through inhibitory control processes engaged either during memory encoding (to disrupt the consolidation of that memory) or retrieval (to disrupt the retrieval of a consolidated memory from our conscious awareness; Anderson & Hanslmayr, 2014). Inhibitory control at encoding has mainly been investigated with two directed forgetting paradigms: (a) In the item-method directed forgetting procedure, participants study items one at a time, and each item is followed by a forget (F) or remember (R) instruction. Later, memory for all items is tested, resulting in worse recall for F items than for R items. (b) In the list-method directed forgetting procedure, participants study two lists of items. The first list is followed either by the instruction to forget (F) or by the instruction to remember (R, in a between-subjects comparison), whereas the second list is followed by the instruction R to all participants. Later, memory of the items from the two lists is tested. The directed-forgetting effect refers to the fact that forget-cue participants typically show impaired List 1 recall compared to remember-cue participants, as well as improved List 2 recall, known as the *costs* and the *benefits* of directed forgetting, respectively (Bjork, 1972; MacLeod, 1998). Inhibitory control at retrieval is often studied with the think/no-think (TNT) paradigm: first, participants study cue–target pairs and are trained to recall the second item in each pair whenever they encounter the first item. Then participants begin the TNT phase, in which they are asked to exert control over

* Corresponding author.
E-mail addresses: pitarque@uv.es (A. Pitarque), Encarna.Satorres@uv.es (E. Satorres), escudero_joa@gva.es (J. Escudero), Salvador.Algarabel@uv.es (S. Algarabel), obeklo@alumni.uv.es (O. Bekkers), Juan.C.Melendez@uv.es (J.C. Meléndez).

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retrieval. On each trial, reminders from the pairs appear in two different colors: when the reminder appears in one color, participants are supposed to recall the response, whereas for the other color reminders, participants are asked to avoid retrieving the response, thus keeping it from entering their awareness. Memory performance is compared on no-think trials, think trials, and items they studied but did not suppress or retrieve (baseline trials), with worse recall on no-think trials (Anderson & Green, 2001). These experimental results have also been replicated with autobiographical materials (Barnier et al., 2007; Noreen & MacLeod, 2014). Some authors think these results do not exclusively support an inhibitory explanation under executive control (e.g. Anderson & Hanslmayr, 2014; Noreen & MacLeod, 2015) because the forget instruction may also induce a deliberate change in participants' internal context (also under their executive control). This change then impairs later recall of the original list due to a mismatch between the context at encoding and the context at retrieval (Manning et al., 2016; Masicampo & Sahakyan, 2014).

The intentional suppression of veridical memories seems to grow more difficult as we age (Anderson, Reinholz, Kuhl, & Mayr, 2011; Sahakyan, Delaney, & Goodmon, 2008; Zacks, Radvansky, & Hasher, 1996; Titz & Verhaeghen, 2010, for a review), which would support the importance of the executive control in the explanation of this effect, given that older people have been shown to have deficits in inhibitory abilities (Hasher & Zacks, 1988) and in binding events to their context (Old & Naveh-Benjamin, 2008). However Aslan, Bäuml, and Pastötter (2007), Sego, Golding, and Gottlob (2006) and Zellner and Bäuml (2006) obtained the same directed forgetting effect in young and older people, which seems to give less relevance to the role played by executive control in the explanation of motivated forgetting. But in a recent meta-analysis Titz and Verhaeghen (2010) have shown that a cue to forget is more effective in younger (d = 1.17) than in older adults (d = 0.81), which would indicate that there is an executive deficit in elderly people.

The DRM experimental paradigm (after Deese-Roediger-McDermott; Deese, 1959; Roediger & McDermott, 1995) made it possible to demonstrate that the study of semantically related words (e.g., *sit*, *desk*) produces the false recall of some unstudied *critical* words (e.g., *chair*) related semantically to them, generically known as false memories. This robust false memory effect has been addressed in a large body of literature (Gallo, 2010, for a review). Through the use of this paradigm, false memories have been shown to increase with age (Devitt & Schacter, 2016, for a review). Two theoretical models have mainly been used to explain this effect in the literature. On the one hand, the *fuzzy-trace* theory (Reyna & Brainerd, 1995) emphasizes that old people, due to their limited capacity to recollect item-specific or contextual information, mainly tend to base their retrieval judgments on their *gist* memory (or the general theme of the information underlying the stimuli studied), giving rise to an increase in both their true and false memories. On the other hand, the *activation-monitoring* theory (Roediger, Watson, McDermott, & Gallo, 2001) establishes that, during study, both studied items and items semantically related to them are activated (due to spreading activation from the former to the latter). At the time of retrieval, the subject carries out a conscious monitoring process to distinguish between studied and non-studied items. Given that non-studied lure items can be highly activated, source-monitoring errors can occur (Johnson, Hashtroudi, & Lindsay, 1993), leading to false memories. False memories can be reduced via a conscious process of recollection rejection, where lures are rejected on the grounds that they do not contain the expected item-specific information (Brainerd, Reyna, Wright, & Mojardin, 2003). That is, whereas activation enhances false memories, monitoring reduces them (Gallo, 2010). Many studies have found support for the correct use of this recollection-based monitoring strategy in young people, but less in healthy older people or people with cognitive impairment, due to their aforementioned contextual or binding deficits (Gallo, Sullivan, Daffner, Schacter, & Budson, 2004; Pitarque et al., 2016).

Various studies have analyzed motivated forgetting of false memories using the DRM paradigm, with varying results and always in young adult participants. Some studies have shown that directed forgetting reduces true recall, but it does not affect false recall (Knott, Howe, Wimmer, & Dewhurst, 2011, exp. 1; Lee, 2008, using a list-method forgetting procedure; Seamon, Luo, Shulman, Toner, & Caglar, 2002), leading to the interpretation that controlled inhibition does not seem to affect false memories. Other studies have shown reduced false recall with directed forgetting instructions (Lee, 2008, using an item-method forgetting procedure; Marche, Brainerd, Lane, & Loehr, 2005), reaching the conclusion that the instruction "forget" is also effective in inhibiting critical words because they form part of the same *gist* memory as the studied words. Finally, another study showed that directed forgetting instructions increase false recall (Kimball & Bjork, 2002), with the explanation being that impairing access to List 1 also impairs participants' ability to use episodically distinctive information to determine that the semantically activated critical items were not on the list. This interpretation is consistent with predictions made both by the *fuzzy-trace* theory (Reyna & Brainerd, 1995) and the *activation-monitoring* theory (Roediger et al., 2001).

Overall, the different interpretations of these discordant results depend on the relative weight assigned to either the automatic activation processes or the monitoring and inhibition processes under executive control (Gallo, 2010). As far as we know, no study has analyzed the role of motivated forgetting of false memories in healthy older people. We think it is relevant to compare young and healthy older people because it will allow us to analyze the role played by monitoring processes in the inhibition of both true recall and false recall, given that older people have been shown to have significant deficits in executive control (Hasher & Zacks, 1988). For example, if the young people were capable of inhibiting both veridical and false memories but the older people were not, this would support the more important role of controlled inhibition, whereas the lack of differences between the two samples would imply a greater role of the automatic activation processes.

Another reason for these inconsistent results might be related to the DRM paradigm's limited sensitivity in capturing the forgetting of false memories because each study list is usually associated with only one critical word, and so each participant contributes only one observation to the critical-item analysis (e.g. Kimball & Bjork, 2002; Knott et al., 2011; Lee, 2008; Seamon et al., 2002). In other words, a lack of differences between the forget and remember instructions on false memories (e.g. Lee, 2008; Marche et al., 2005) will always raise doubts about whether this null result occurs because the forget instruction is not effective in inhibiting the critical words, or because our procedure has low sensitivity due to the small number of critical words. In an attempt to solve this