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## Ego depletion results in an increase in spontaneous false memories

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### ABSTRACT

The primary aim of the current study was to examine whether depleted cognitive resources might have ramifications for the formation of neutral and negative spontaneous false memories. To examine this, participants received neutral and negative Deese/Roediger–McDermott false memory wordlists. Also, for half of the participants, cognitive resources were depleted by use of an ego depletion manipulation (solving difficult calculations while being interfered with auditory noise). Our chief finding was that depleted cognitive resources made participants more vulnerable for the production of false memories. Our results shed light on how depleted cognitive resources affect neutral and negative correct and errant memories.

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### 1. Introduction

Recently, there is an upsurge in research concerning the mechanisms underlying the development of spontaneous false memories. These are the types of false memories that arise without external pressure and hence, develop spontaneously. The reason why memory scholars are increasingly interested in the fallibility of memory is that this research can shed light into the building blocks of our memory system. Furthermore, memory scholars are interested in the examination of spontaneous false memories as these types of false memories are robust, often evoked automatically and are hard to inhibit (Brainerd, Reyna, & Ceci, 2008). These reasons make these false memories more easily studied in an experimental setting.

There exist different theoretical frameworks to explain the formation of false memories. Fuzzy trace theory (FTT; Brainerd et al., 2008) posits that two opponent memory traces are stored during the experience of an event (e.g., remembering wordlists). Verbatim traces are involved in the storage of item-specific, surface characteristics of an experience (e.g., font or color of words) whereas gist traces capture the semantic structure of an experience. Since verbatim traces fade rapidly over time, false memories rely predominantly on the retrieval of gist traces. However, when verbatim traces are retrieved, false memory production will be inhibited; a phenomenon that is also called recollection rejection.

There are also theories that use spreading activation as a vital mechanism for the production of false memories. For example, activation-monitoring theory (AMT; Roediger, Watson, McDermott, & Gallo, 2001) postulates that two processes underlie the development of false memories. These processes involve spreading activation and monitoring. Spreading activation can result in the activation of related but unrepresented concepts in our knowledge base. Furthermore, when people are not able to correctly monitor the sources of their memories, false memories can occur as well. Associative activation theory (AAT; Howe, Wimmer, Gagnon, & Plumpton, 2009) that is partly based on AMT also specifies that true and false memory

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formation rely on automatic associative processes. The basic premise of AAT is that the processing of one word leads to spreading activation to corresponding and related theme nodes in our knowledge base. AAT states that false memories arise because spreading activation will also target theme nodes that were not part of an experienced event. Furthermore, the faster and stronger these associative processes are, the more likely false memories will develop. Although extensive evidence exists about the key factors underpinning the formation of false memories (e.g., gist processing; Brainerd et al., 2008; spreading activation; Howe et al., 2009), many issues, however, are still ill-explored. One pertinent issue that the current study addressed is whether depletion of cognitive resources might have ramifications for the development of false memories. So, the aim of the present study was to examine whether depleted cognitive resources would have any consequences on the formation of spontaneous false memories.

## 2. Executive functioning and false memory

A cognitive system that relies heavily on cognitive resources is executive functioning. Executive functioning refers to an umbrella concept for cognitive processes as working memory, planning, and inhibition that are all general-purpose control mechanisms regulating the dynamics of cognition (Miyake et al., 2000). Interestingly, studies show that deficiencies in executive functioning are related to an enhanced risk for false memory formation (e.g., Peters, Jelicic, Verbeek, & Merckelbach, 2007; Watson, Bunting, Poole, & Conway, 2005). For example, in a study by Peters and colleagues, participants were subjected to a false memory paradigm that induces robust levels of spontaneous false memories (Deese/Roediger–McDermott (DRM) paradigm; see below) and had to perform several working memory tasks (forward and backward digit span). They found that poor working memory on the backward digit span significantly predicted false memory propensity. In a similar vein, Watson et al. (2005) showed that participants with a low working memory capacity measured by an operation span task were more susceptible to spontaneous false memories relative to participants with a high working memory capacity.

The theoretical rationale behind executive functioning and false memories is that deficits in executive functions impact the ability to monitor the sources of memories. In general, source monitoring refers to the mechanism involved in judging the origins of memories (Johnson, Hashtroudi, & Lindsay, 1993). More specifically, during successful source monitoring, images, thoughts, and feelings of experienced events are correctly assigned to particular sources of earlier experiences. In this regard, false memories emerge when people erroneously attribute internally generated sources to external sources. With respect to the relation between executive functions and source monitoring, low executive functioning results in more effort being required to control cognitive processes and hence, more difficulties to keep control over the sources of memories.

Although previous research (e.g., Watson et al., 2005) has revealed a link between executive functioning and false memories, these earlier studies have only focused on subgroups of people differing in executive functioning and assessed whether these groups can be differentiated in levels of false memories. There exists a related line of research which has experimentally examined whether deficits in executive functioning impacts false memories. In these studies, the effect of divided attention on false memory levels was examined. Dividing attention interferes with the ability to perform executive functions. This research line has revealed that divided attention can increase (e.g., Otgaar, Peters, & Howe, 2012) or decrease false memory levels (e.g., Dewhurst, Barry, Swannell, Holmes, & Bathurst, 2007; Experiment 2) in children and adults (see also Wimmer & Howe, 2010).

For example, in a study by Knott and Dewhurst (2007), false memories were elevated when divided attention was introduced during the retrieval of information while false memories were reduced when dividing attention was incorporated during the encoding of information. Otgaar, Peters, et al. (2012) however found a developmental shift in that dividing attention decreased children's false memory levels while it enhanced false memory levels. So, there exist mixed results with respect to the effect of dividing attention on false memories. These mixed results are partially due to the use of different divided attention tasks and the use of recall or recognition tests (Otgaar, Peters, et al., 2012).

Besides using divided attention to experimentally target executive functioning and thereby impacting cognitive resources, there also exists a wealth of related research showing that cognitive resources can be depleted by a lack of self-control. Remarkably, to date, there is no study whether a lack of self-control has an effect on the development of false memories. The present study was designed to examine whether a lack of self-control might precipitate false memories.

## 3. Ego depletion

Intriguingly, an abundance of studies shows that cognitive resources can successfully be depleted by using so-called ego depletion manipulations (e.g., Baumeister, Vohs, & Tice, 2007; Hagger, Wood, Stiff, & Chatziantis, 2010). Ego depletion refers to a state of reduced self-control due to engaged acts of self-control. Specifically, studies on ego depletion demonstrate that being involved in acts of self-control affects a limited store of self-control that when affected results in reduced abilities for future self-control. In a study by Muraven, Tice, and Baumeister (1998; Study 1), for example, participants who had to regulate their emotions when watching an upsetting movie quitted earlier during a physical self-control task relative to control participants. Furthermore, Baumeister, Bratslavsky, Muraven, and Tice (1998) showed that participants who had to resist the

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