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Consciousness and Cognition

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

No effects of executive control depletion on prospective memory retrieval processes



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ARTICLE INFO

Article history:

Received 31 July 2013

Available online 20 May 2014

Keywords:

Prospective memory

Executive Control Depletion Cognitive

Fatigue

ABSTRACT

Research has suggested that prospective memory retrieval is reliant on executive control processes, and the degree to which these processes are necessary for intention fulfillment is dependent on a host of variables related to the prospective memory task. Based on results suggesting that aspects of the prospective memory task vary in their need for executive control, the current study examined the possibility that executive control depletion from the Stroop task would negatively transfer to prospective memory performance. Depletion of executive control, measured objectively in a Stroop task, did not impair prospective memory performance in either low or high cue-target association conditions. However, participants' subjective assessments of their own cognitive fatigue correlated significantly with their prospective memory performance, regardless of the association between cues and target responses.

Published by Elsevier Inc.

1. Introduction

Prospective memory refers to the process of remembering to perform an intended action at the appropriate time in the future (McDaniel & Einstein, 2007). The scope of these actions ranges from everyday tasks, such as remembering to go to the grocery store, to activities with potential life-altering consequences, such as remembering to monitor a child's safety. Prospective memory often blends demands on attention and retrospective memory processes in any given memory task (Smith & Bayen, 2004). To assess these demands, prospective memory failures are typically studied in the laboratory by having participants busily engage in some ongoing activity in which prospective memory cues are presented that should stimulate retrieval of previously established intentions. The current research explored the hypothesis that placing demands on executive control processes after establishing an intention but prior to beginning the ongoing activity where cues are to be detected will interfere with subsequent prospective memory performance (i.e., executive-control depletion).

1.1. Prospective memory retrieval processes: cue-intention association

McDaniel and Einstein (2000) hypothesized that if a prospective memory cue has a high degree of association with a target action (e.g., the intention is to buy milk and the cue is passing the grocery store), then reflexive episodic memory retrieval processes will promote retrieval of the intention upon encountering the cue, contrasted with a situation where there was a lesser degree of association between cue and intended action. To test this hypothesis, McDaniel, Guynn,

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Einstein, and Breneiser (2004) asked participants to remember to write down a specific word in response to the occurrence of a set of specific target words. To hold detection processes constant, the target words remained the same across conditions, but the response words varied; in the high-association condition, the cue (e.g., spaghetti) had a strong associative relation to the target response (e.g., say “sauce”) and in the low-association condition the cue (e.g., spaghetti) was weakly associated to the target response (e.g., say “steeple”). Additionally, half of the participants in each condition concurrently completed a secondary task that limited the availability of executive-control processes for the prospective memory task. The data showed that for participants in the high-association condition, prospective memory performance was unaffected by the executive-control demands of the secondary task, but for participants in the low-association condition, prospective memory performance was significantly impaired by the secondary task. These results suggest that executive control is necessary for successful prospective memory fulfillment only when the use of controlled retrieval processes (i.e., inhibition of competitors, temporal-contextual search, etc.) is necessary for successful prospective memory performance. Therefore, under conditions of low cue-intention associations, executive control demands intervening between intention establishment and the opportunity to fulfill the intention should lead to prospective memory impairments.

1.2. Depletion

Depletion refers to the idea that performing tasks related to controlling or modifying thoughts or behavior requires the use of cognitive resources and that by performing these activities, the availability of these resources can be diminished, thereby negatively transferring to performance on subsequent tasks that utilize the same resource pool.

Ego depletion refers to a temporary reduction in one's capacity or willingness to engage in volitional acts (e.g., self-control, making choices, initiating action) due to previous engagement of volition (Baumeister, Bratslavsky, Muraven, & Tice, 1998). Baumeister et al.'s use of ego as a concept stemmed from Freud's definition of the ego as “the part of the psyche that must deal with the reality of the external world by mediating between conflicting inner and outer pressures” and Freud's assumption that the ego required energy to make these choices (p. 1253). Baumeister et al. (1998) conducted a series of experiments to test his theory of ego depletion by using a variety of volitional acts to attempt to deplete ego resources and then measuring performance on subsequent volitional acts to determine whether a detrimental effect had occurred.

For example, in one experiment Baumeister and colleagues used self-control as the volitional act, instructing a group of participants to eat radishes while tempted with the appealing presence of chocolates, which they were specifically instructed not to eat. A second group had the instructions reversed (eat chocolates, not radishes), and a control group did not eat any food. Following this exercise participants were asked to try and solve a puzzle that, unbeknownst to them, was unsolvable; the researchers, working under the assumption that persistence is a function of self-control, measured how long participants focused on solving the puzzle before giving up. The participants in the radish-eating group worked on the puzzle for significantly less time than either the chocolate-eating or control groups; the chocolate-eating group (who presumably did not have to exercise much self-regulation) did not differ significantly from the control group in terms of persistence. These results provided support for the hypothesis that varying forms of volitional acts draw from the same limited resource pool.

1.3. Executive control depletion

Schmeichel (2007) extended the concept of ego depletion to apply to any task that falls under the label of an executive control function, which broadly refers to the ability to modify one's thoughts and actions (Baddeley, 1986; Norman & Shallice, 1986 in Schmeichel (2007), p. 241). These executive control functions can include controlling attention, updating memory, and inhibiting or exaggerating automatic responses (Schmeichel, 2007). For example, in the classic Stroop task (1932) participants are presented with a series of words denoting a color that are also presented in a colorful font. Participants are instructed to name the color of the font and to avoid reading the word. In this task, words and font color can either match (congruent trials) or mismatch (incongruent trials). Across many published studies in experimental psychology, participants are slower on incongruent trials than congruent trials indicating that executive control processes are necessary for avoiding the automatic response to read the word in favor of naming the color (i.e., the Stroop Effect; for a review, see MacLeod, 1991). Of course, participants could complete a version of the Stroop task under the instruction to simply read the color words thereby removing any executive control demands inherent in avoiding automatic reading responses.

Of particular interest to the current study is Schmeichel's (2007) research concerning the impact of executive control depletion on memory updating and maintenance. Schmeichel's first experiment examined the effects of depleting attention control on the ability to update working memory. Participants in the experiment were asked to watch a short video with unrelated words clearly visible at the bottom of the screen appearing for 15 s each. The attention control group was asked to watch the clip but avoid looking at or reading the words appearing on the screen (similar to the demands of a standard Stroop task), whereas the control group was merely asked to watch the clip (they were provided with no further instructions). After watching the video, participants engaged in either an operation span task or a sentence span task, both of which served to measure working memory performance. The operation span task consisted of evaluating the correctness of math equations and later recalling a set of target words given after each equation; the sentence span task consisted of answering a multiple-choice question about a sentence and later recalling the last word of each sentence. Results provided support for the executive control depletion hypothesis; participants in the attention control condition performed significantly worse

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