Available online at www.sciencedirect.com
SCIENCE DIRECT®
Journal of Memory and Language 52 (2005) 578–594
Journal of Memory and Language
www.elsevier.com/locate/jml

Executive processes, memory accuracy, and memory monitoring: An aging and individual difference analysis ☆

Matthew G. Rhodes *, Colleen M. Kelley

Department of Psychology, Florida State University, Tallahassee, FL 32306-1270, USA

Received 31 August 2004; revision received 21 January 2005
Available online 3 March 2005

Abstract

The current study examined the neuropsychological correlates of memory accuracy in older and younger adults. Participants were tested in a memory monitoring paradigm developed by Koriat and Goldsmith (1996), which permits separate assessments of the accuracy of responses generated during retrieval and the accuracy of monitoring those responses. Participants were also administered a battery of tests designed to measure executive functioning and speed of processing. Results indicated that both age and executive measures were predictive of accuracy, while speed of processing measures accounted for little of the variability in accuracy. Path analyses demonstrated that a substantial portion of the effect of executive function measures on memory accuracy in free report was mediated by the quantity of correct responses available in forced report, which in turn was partially mediated by monitoring accuracy. These data suggest that individual differences in executive function are important in memory accuracy.

Keywords: Memory; Metamemory; Memory monitoring; Aging; Executive function

Introduction

The quality of one's memory has traditionally been characterized in terms of the quantity of ideas or the number of aspects of events that are recalled. However, memory accuracy has been the subject of growing interest (see Koriat, Goldsmith, & Pansky, 2000; Roediger, 1996 for reviews) with a particular focus on errors of commission. For example, memory accuracy can be quite low after the introduction of misleading post-event information (e.g., Loftus, Miller, & Burns, 1978), after studying texts that introduce strong inferences (e.g., Owens, Bower, & Black, 1979), and in paradigms such as the Deese–Roediger–McDermott (Deese, 1959; Roediger & McDermott, 1995), or DRM paradigm, in which studying lists of associates of a central, nonpresented item induces high levels of false recall. In

☆ Parts of this research were included in a Dissertation submitted to The Florida State University by Matthew G. Rhodes. We thank the other members of the dissertation committee, Michelle Bourgeios, Neil Charness, Katinka Dijkstra, and Ashby Plant for their helpful comments throughout the course of the research. We also thank John Dunlosky and Morris Goldsmith for their comments and suggestions on an earlier version of the manuscript. We are indebted to Matthew Campioni, Justin Crowe, Mary Currie, Kristy McDaniel, Kathleen Muller, Lisa Spaulding, and Cicely Procipio for their assistance in testing subjects.

* Corresponding author. Present address: Department of Psychology, Washington University in St. Louis, St. Louis, MO 63130, USA.
E-mail address: mrhodes@artsci.wustl.edu (M.G. Rhodes).

0749-596X/$ - see front matter
doi:10.1016/j.jml.2005.01.014

the current study, we use an individual differences analysis across younger and older adults to assess the role of executive functions in memory accuracy and suggest that they are related to both the quantity of correct information available to the rememberer and the monitoring of this information.

Executive functions have been specified in a number of ways and may include the monitoring and control of behavior, suppression of irrelevant information, reasoning, updating information in working memory, inhibition of prepotent responses, planning, shifting, and control of attention, among others (e.g., Baddeley, 1996; Fisk & Sharp, 2004; Kane & Engle, 2002; Miyake et al., 2000; Shimamura, 2000a, 2000b; Waltz et al., 1999). Several researchers have suggested that a decline in executive functions is a primary factor in the cognitive deficits present in aging populations (e.g., Moscovitch & Winocur, 1995; West, 1996; Whelihan & Lesher, 1985). Executive functions are presumably localized in the prefrontal cortex (e.g., Duncan, 1995; Kane & Engle, 2002; Shallice & Burgess, 1991; Waltz et al., 1999), which deteriorates more rapidly with age than other cortical regions (see Raz, 2000, for a review). There is extensive behavioral evidence indicating that older adults perform more poorly than young adults on a number of tasks thought to tap executive functioning that are likewise sensitive to frontal lobe lesions. For example, older adults make more perseverative errors on the Wisconsin Card Sorting Test (WCST; see Rhodes, 2004, for a review), show greater interference on incongruent trials of the Stroop task (Houx, Jolles, & Vreeling, 1993), and produce fewer words on tests of verbal fluency (e.g., Howard, 1980).

The motivation for the current study is a set of findings indicating that variations in performance on neuropsychological tests of executive function predict the memory accuracy of older adults (e.g., Butler, McDaniel, Dornburg, Roediger, & Price, in press), who generally exhibit more false memories than younger adults (e.g., Bartlett, Halpern, & Dowling, 1995; Jacoby, 1999a; Kelley & Sahakyan, 2003; Norman & Schacter, 1997). For example, Butler et al. (in press) demonstrated that older adults scoring poorly on tests of executive function were highly likely to make errors of commission during recall in the DRM paradigm. In contrast, older adults with relatively high scores on measures of executive function exhibited levels of accuracy comparable to young adults. This is consistent with data from other memory tasks showing significantly better memory performance by older adults scoring high on measures of executive functioning in comparison to groups of older adults with relatively poor performance on such measures (e.g., Davidson & Glisky, 2002; Glisky, Polster, & Routhieaux, 1995; Glisky, Rubin, & Davidson, 2001; McDaniel, Glisky, Rubin, Guynn, & Routhieaux, 1999; see also Crawford, Bryan, Luszcz, Obonsawin, & Stewart, 2000).

While executive processes are predictive of memory accuracy, the specific nature of this relationship is not entirely clear. We consider three possibilities. First, executive functions may be crucial to the encoding and retrieval of accurate information. This may include binding information during encoding (cf., Chalfonte & Johnson, 1996; Glisky et al., 2001; Henkel, Johnson, & De Leonardis, 1998) or maintaining an appropriate retrieval set that allows one to generate cues that are likely to lead to the retrieval of accurate information (Burgess & Shallice, 1996; Moscovitch & Melo, 1997; Norman & Schacter, 1996). For example, Norman and Schacter (1996) have proposed that high levels of false memories observed in frontal patients occur either because they are totally unable to recapitulate the study context or because they produce "unfocused retrieval descriptions" that provide only a vague representation of the study context. False memories in older adults may also be a consequence of relying on vague or unfocused representations of study episodes that lack specific details indicative of prior occurrence (e.g., Jacoby, 1999a, 1999b; Jennings & Jacoby, 1997; Kelley & Sahakyan, 2003; see also Parkin & Walter, 1992). Thus, executive processes may in part mediate encoding and/or retrieval processes that are important for memory accuracy.

Second, executive functions may be important for monitoring candidate responses for accuracy (Shimamura, 2000a, 2000b). Monitoring and controlling the contents of cognitive processes likely comprises an important executive function (cf. Fernandez-Duque, Baird, & Posner, 2000) that has implications for the attainment of accuracy (e.g., Shimamura, 2000a, 2000b). Evidence from frontal patients indicates that they have considerable difficulty with complex metacognitive tasks such as memory monitoring (e.g., Janowsky, Shimamura, & Squire, 1989; Vilkki, Servo, & Surmaaho, 1998; see Shimamura, 1996 for a review). In addition, there is some evidence that measures of executive function are predictive of certain types of memory monitoring judgments. For example, Souchay, Isingrini, and Espagnet (2000) reported that the accuracy of feeling-of-knowing judgments was positively correlated with performance on the WCST and verbal fluency tasks (see also Souchay, Isingrini, Clarys, Taconnat, & Eustache, 2004). Given this, any relationship between accuracy and measures of executive function may in part reflect memory monitoring.

Third, these factors may not be independent. That is, the relationship between executive functions and monitoring may be partially mediated by the quality or quantity of candidate responses available in memory. Kelley and Sahakyan (2003) suggest that monitoring depends largely on the quality of information available to the monitoring process, such that monitoring will be more difficult if participants retrieve vague or undifferentiated information. For example, they demonstrated that the