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Effects of mild cognitive impairment on emotional scene memory

J.D. Waring[a,b,*], H.R. Dimsdale-Zucker[b,c], S. Flannery[d,e], A.E. Budson[d,e], E.A. Kensinger[b]

[a] Dept. of Psychology, Saint Louis University, St. Louis, MO, USA
[b] Dept. of Psychology, Boston College, Chestnut Hill, MA, USA
[c] Dept. of Psychology, University of California at Davis, Davis, CA, USA
[d] Center for Translational Cognitive Neuroscience, VA Boston Healthcare System, Boston, MA, USA
[e] Boston University Alzheimer's Disease Center, Department of Neurology, Boston University School of Medicine, Boston, MA, USA

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ABSTRACT

Young and older adults experience benefits in attention and memory for emotional compared to neutral information, but this memory benefit is greatly diminished in Alzheimer's disease (AD). Little is known about whether this impairment arises early or late in the time course between healthy aging and AD. This study compared memory for positive, negative, and neutral items with neutral backgrounds between patients with mild cognitive impairment (MCI) and healthy older adults. We also used a divided attention condition in older adults as a possible model for the deficits observed in MCI patients. Results showed a similar pattern of selective memory for emotional items while forgetting their backgrounds in older adults and MCI patients, but MCI patients had poorer memory overall. Dividing attention during encoding disproportionately reduced memory for backgrounds (versus items) relative to a full attention condition. Participants performing in the lower half on the divided attention task qualitatively and quantitatively mirrored the results in MCI patients. Exploratory analyses comparing lower- and higher-performing MCI patients showed that only higher-performing MCI patients had the characteristic scene memory pattern observed in healthy older adults. Together, these results suggest that the effects of emotion on memory are relatively well preserved for patients with MCI, although emotional memory patterns may start to be altered once memory deficits become more pronounced.

1. Introduction

While the typical belief is that memory declines with advancing age, memory for emotional information often remains relatively well preserved across the lifespan (Hess, 2005; Mather and Carstensen, 2005; Park et al., 2002). A wealth of evidence has shown that younger and older adults preferentially attend to emotional information and also subsequently remember it better than neutral information (Denburg et al., 2003; Leclerc and Kensinger, 2008; Otani et al., 2007; reviewed by Murphy and Isaacowitz (2008)). In contrast, emotion does not convey the same benefits upon memory in those with moderate to severe stages of Alzheimer's disease (AD); patients with AD retain very little neutral (reviewed by McKhann et al. (2011)) or emotional information (reviews by Klein-Koerkamp et al. (2012) and Waring and Kensinger (2010)). However, the trajectory of this decline is unclear; it raises questions about the point in the disease course when the emotional enhancement in memory dissipates.

There are still many questions remaining about the characterization of Mild Cognitive Impairment (MCI), preceding a diagnosis of AD. MCI as a clinical condition has not been researched to nearly the same extent as AD. The limited research about emotional memory in MCI has provided disparate findings and left a number of questions remaining. The extent to which the enhancing effect of emotional enhancement on memory is preserved in MCI is unclear—does it dissipate early in the disease progression at the same rate as overall memory decline, or is emotional enhancement in memory relatively well preserved? Some studies of working memory for emotional images have revealed a negativity bias in the memories of MCI patients (but the negative items were also more arousing than positive items, making it impossible to attribute these differences to valence (how positive or negative) alone (Dohnel et al., 2008, 2007)). Another investigation of MCI patients' recognition memory for emotional and neutral IAPS images showed higher true recognition and false alarms for negative compared to positive or neutral images, and also that dividing attention did not impact discrimination ability (Sava et al., 2016). In other studies MCI patients have shown a memory benefit for positive or negative words (Brueckner and Moritz, 2009; Callahan et al., 2016), but impaired memory for faces studied with emotional expressions (Wang et al., 2013; Werheid et al., 2010). A recent study examined recall and recognition memory for a short series of emotional pictures

* Corresponding author at: Saint Louis University, Dept. of Psychology, Morrissey Hall, 3700 Lindell Blvd., St. Louis, MO, USA.
E-mail address: waringjd@slu.edu (J.D. Waring).

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(8 of each positive, negative, neutral) in healthy older adults, MCI, and patients with unspecified diagnosis of 'dementia'(Gorenc-Mahmutaj et al., 2015). The authors reported comparable delayed recognition for positive and negative pictures in healthy older adults and MCI, but better memory for positive than negative pictures in patients with dementia. Given the small number of studies and differences in diagnostic testing measures reported, it is difficult to draw conclusions about the extent of impairment or preservation in emotional memory ability in MCI from the existing literature. The disparate findings among the few studies of emotional memory in MCI may be due to differences between task design, stimuli, or degree of impairment among participants (Klein-Koerkamp et al., 2012). Further investigation of the extent of impairment and preservation of selective emotional memory enhancement in MCI can increase our understanding of the course and extent of functional deficits resulting from early AD pathophysiological changes.

The effects of attention and encoding-related phenomena upon subsequent memory are a particularly important area to investigate in patients with MCI because the attention deficits observed in MCI parallel those of healthy older adults: namely, difficulty ignoring or suppressing irrelevant information (Gazzaley and D'Esposito, 2007; Hasher and Zacks, 1988). Previous studies have shown that dividing attention resources during encoding of emotional information is one factor that can quantitatively and qualitatively affect contents of memory in young adults (Clark-Foos and Marsh, 2008; Kensinger and Corkin, 2004; Kern et al., 2005), and older adults (Mather and Knight, 2005: expt 3). Stimuli with emotional arousal increase the difficulty of working memory tasks because they bias attention away from less arousing information also competing for processing resources (Mather and Sutherland, 2011). There is strong evidence for progressive decline in attention processing abilities from healthy aging into MCI; patients with MCI have more difficulties in tasks requiring divided attention than healthy older adults (Okonkwo et al., 2008). These studies provide further evidence that initial attention and encoding phase processes play an important role in subsequent memory in healthy and pathological aging. Notably, older adults with normal cognition often have AD neuropathology while remaining presymptomatic of AD for years (Morris et al., 1996), so examining the breakdown in attention and encoding processes with the onset of MCI may provide information about the earliest behavioral changes in older adults that signal advancing underlying pathology.

The first goal of this study was to examine the early effects of the AD pathophysiological process compared to healthy aging on the type of information retained from emotional scenes. To address this goal, healthy older adults and patients with a mild degree of AD pathophysiological change (psychometrically fitting clinical criteria for MCI; Sperling et al., 2011) viewed photographic visual scenes containing positive, negative, or neutral items within a neutral background context. It seemed likely that although early AD pathophysiological changes cause mild memory loss, the relative preservation of brain regions vital for emotion processing (Apostolova and Thompson, 2008; Whitwell et al., 2007) would allow emotional information to retain a higher degree of salience in memory than neutral information. Consequently, we expected that MCI patients would demonstrate selective memory for emotional items in scenes similar to that of healthy older adults.

The second goal of this study was to examine whether dividing the attention of older adults could serve as a model for the memory patterns present in MCI patients granting full attention to encoding. To address this goal, an additional group of older adults encoded emotional and neutral scenes under divided attention. We hypothesized that dividing attention while encoding emotional scenes may not impair encoding of emotionally salient items, but would particularly inhibit older adults' ability to successfully encode background scene information. The disruption of early attention processes in older adults may provide a model of the pattern of results naturally developing in MCI patients, leading to similar memory patterns between older adults with divided attention and MCI patients. There is a growing body of research about MCI patients' memory for neutral information, but still little examining emotional memory in MCI. This research advances knowledge about the earliest effects of the AD pathophysiological process on memory for positive and negative information. Exploratory analyses also examined whether there were differences between higher- and lower-performing MCI patients' memory patterns, to more fully explicate the trajectory of emotional memory changes within the spectrum from healthy aging to the cusp of AD.

2. Methods

2.1. Participants

Participants included 22 patients with a mild degree of AD pathophysiological change, as determined by a neurologist (AEB) or clinical neuropsychologists. 46 healthy older adults approximately matched to the patient sample in age and years of education, (age M=74.4 years, SD=7.0; education M=16.2 years, SD=2.4; 21 men, 25 women). Individuals in the patient group fit criteria for diagnosis of MCI due to AD pathology including 1) concern of a change in cognition over time, 2) impairment in one or more cognitive domains including memory, executive function, attention, language, and visuospatial skills; most commonly presenting with impairment in episodic memory, 3) preservation of independent functional abilities, and 4) not demented (Albert et al., 2011). Data from four individuals were not included in analyses due to elevated scores on a self-reported measure of depression (GDS >6), and an additional participant repeatedly fell asleep during the protocol, so the final patient sample included 17 participants (age M =79.5 years, SD=5.7; education M =15.6 years, SD=2.5; 12 men, 5 women).

Patients were recruited from the Bedford, MA Veterans Administration Hospital, Boston University Alzheimer's Disease Center, and a local adult day health program. Older adults were recruited using fliers posted in the community. Individuals were excluded if they reported a history of psychiatric or neurological disorder (other than MCI) at any point over the past 3 years or if they had participated in a study in this research laboratory that used the same stimulus set or task instructions. All participants were native English speakers with normal or corrected to normal vision.

At the time of the study, participants scored within the normal range on measures of depression and anxiety (see Table 1). Participants were paid at the rate of $10 per hour, and took 2–2.5 h to complete the study protocol. Written informed consent was obtained from all participants prior to beginning the study, in accordance with the protocols approved by the Institutional Review Boards of Boston College (healthy older adults) or the Boston University Medical Center (MCI patients), and the study was performed in accordance with the standards of the 1964 Declaration of Helsinki.

2.2. Materials

The stimulus set included 50 positive, 50 negative, and 50 neutral items and 150 backgrounds. Scenes were created by placing an emotional or neutral item on a background (e.g., a snake by a river). The stimulus set is a subset of the items and backgrounds used in prior studies (Waring and Kensinger, 2009, 2011). Prior ratings from healthy younger and older adults (using a 7-pt scale) indicated that positive (arousal M =3.12; range 2.57–4.47; SD=.58) and negative items (arousal M =3.29; range 2.00–3.75; SD=.42), were significantly more arousing than neutral items (arousal M =2.25; range 1.07–3.40; SD=.62; $F(1,149) > 102.02$, $p < .0005$). An important methodological improvement over our earlier studies investigating emotional scene memory (Waring, Addis, and Kensinger, 2013; Waring and Kensinger, 2009, 2011) is that the sets of positive and negative items were