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Research report

Emotional memory enhancement in respect of positive visual stimuli in Alzheimer's disease emerges after rich and deep encoding

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ABSTRACT

Healthy participants remember emotional stimuli better than neutral stimuli. In normal, older adults this emotional enhancement of memory (EEM) was mostly seen in respect of positive stimuli (*positivity bias*) after rich and deep encoding. The results relating to this effect in Alzheimer's disease (AD) patients are fairly inconsistent. The goal of the present study was to ascertain whether EEM in AD patients depends on the depth and the richness of encoding. Twenty-one patients with mild-to-moderate AD and 23 age-and-education-matched controls completed two study phases, each followed by a retrieval phase. The first study phase consisted of a natural/man-made categorization task followed by a recognition task, whereas the second, which involved the stimuli used in the recognition task, allowed for richer and deeper encoding as a result of repetition and naming of the stimuli and presentation of the same semantic cues at encoding and retrieval. The second study phase was followed by free and cued recall tasks and a recognition task. After the first study phase we observed EEM in respect of negative and positive stimuli in controls, but not in AD patients. After the second study phase, the *positivity bias* was observed in the free recall task in controls but not in AD patients. In the cued recall and recognition tasks, however, both groups showed the *positivity bias*. Based on our results, AD patients present a *positivity memory bias* when encoding is sufficiently rich and deep, and when support is provided at the time of retrieval (cued recall or recognition tasks).

Abbreviations: AD, Alzheimer's disease; EEM, Emotional enhancement of memory.

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1. Introduction

In healthy young and older participants declarative memory for emotional information is typically better than memory for non-emotional information (LaBar & Cabeza, 2006; Reisberg & Heuer, 2004). Numerous neuroimaging and neuropsychology studies have suggested that emotional enhancement of memory (EEM) relies on several cerebral structures, especially the amygdala, which recruits sensory-processing regions in order to increase attention paid to emotional information and, thus, encoding of these stimuli (attention-mediation hypothesis) (Talmi, Anderson, Riggs, Caplan, & Moscovitch, 2008), and modulates the hippocampal long-term memory consolidation processes (consolidation-mediation hypothesis) (McGaugh, 2000; Vuilleumier, Richardson, Armony, Diver, & Dolan, 2004).

EEM has also been studied in Alzheimer's disease (AD), a condition characterised by a gradual decline in declarative memory (Greene, Baddeley, & Hodges, 1996) attributable to neuropathological changes in the medial temporal lobes, notably the amygdala and hippocampus (Braack & Braack, 1991; Poulin, Dautoff, Morris, Feldman Barrett, Dickerson, 2011). Despite early atrophy of the amygdala, emotion processing is relatively spared in AD (Boller et al., 2002; Hamann, Monarch, & Goldstein, 2000), whereas data regarding the presence of EEM are fairly inconsistent (see Klein-Koerkamp, Baciu, & Hot, 2012 for a review). Therefore, it seems factors other than impaired emotional processing can account for the contradictory results concerning the presence of EEM in AD. In the present study we investigated whether rich and deep encoding might permit the emergence of EEM in AD.

1.1. *Emotional memory enhancement in healthy ageing*

During healthy ageing the volume of the amygdala remains relatively intact (Good et al., 2001), and emotional processing seems to be preserved. Healthy older participants' subjective ratings of valence and arousal (Kensinger, 2008; Kensinger & Corkin, 2004; Kensinger, Piguet, Krendl, & Corkin, 2005) and electro-dermal responses (Denburg, Buchanan, Tranel, & Adolphs, 2003) for emotional stimuli are similar to those of healthy young participants.

Despite the general decline in episodic memory observed in normal ageing, EEM has frequently been described in healthy older participants after short (Kensinger, 2008; Yang & Ornstein, 2011) and long (Denburg et al., 2003) retention intervals. It has also been observed after different types of encoding: incidental (Kensinger et al., 2005; Mather & Carstensen, 2003; Mather & Knight, 2005; Thomas, 2006; Yang & Ornstein, 2011) and intentional (Kensinger et al., 2005), and in different types of retrieval task: free recall (Mather & Knight, 2005; Yang & Ornstein, 2011) and recognition (Kensinger, 2008; Kensinger et al., 2005). In addition, EEM was found for different types of stimuli: pictures (Kensinger et al., 2005; Waring & Kensinger, 2009; Yang & Ornstein, 2011), words (Kensinger, 2008; Thomas, 2006), human faces (Denburg et al., 2003; Mather & Carstensen, 2003) and public events (Kensinger, 2006; Petrican, Moscovitch, & Schimmack, 2008).

Numerous studies have reported a *positivity memory bias* in healthy older participants. Contrary to young participants (Ochsner, 2000), their memory performance is better for positive stimuli than for negative and neutral ones (Charles, Mather, & Carstensen, 2003; Kensinger et al., 2005; Thomas, 2006), the critical contrast being between positive and negative stimuli (Reed, Chan, & Mikels, 2014). Such a pattern of results seems to stem from the fact that older participants' memory is worse than that of young participants for negative, but not for positive stimuli. This may be linked to older people's tendency to favour emotionally gratifying information and to avoid and forget information that might increase negative affect (Mather, 2006). For example, they spend more time exploring positive stimuli and less time exploring negative stimuli than healthy young participants (Knight et al., 2007; Mather & Carstensen, 2003). In an attempt to explain this *positivity bias*, the *theory of socio-emotional selectivity* (Carstensen, Isaacowitz, & Charles, 1999) proposed that healthy older adults tend to maintain positive affect by regulating their emotions by spontaneously focussing their attention on pleasant information and by processing it in a more self-referential way than healthy young participants (Murphy & Isaacowitz, 2008; Yang & Ornstein, 2011). Neuroimaging studies support this hypothesis, showing similar amygdala activity in response to positive stimuli in healthy young and older participants, but reduced activity in healthy older participants in response to negative stimuli (Mather et al., 2004). Moreover, the prefrontal cortex, which is known for its contribution to the cognitive control of emotions, seems to be more active in response to emotional stimuli in healthy older participants than in young participants (Nashiro, Sakaki, & Mather, 2011).

In fact, most behavioural studies that found the *positivity memory bias* in healthy older participants allowed controlled processing of information at encoding and/or retrieval (Kensinger, 2008; Leclerc & Kensinger, 2011; Mather & Knight, 2005). It has been pointed out that this bias is observed especially with moderately arousing stimuli because this type of stimuli involves more controlled processing, unlike highly arousing stimuli which involve rather automatic processing (Leclerc & Kensinger, 2008; Mather & Knight, 2005). It seems that intentional encoding instructions (Chainay et al., 2014) and repeated retrieval of information (Mather & Knight, 2005) increase the positivity bias in healthy older participants.

1.2. *EEM in AD*

On account of early atrophy of medial temporal regions, especially the amygdala and hippocampus, one would expect emotional processing and EEM to be impaired in AD. However, emotional processing appears to be relatively preserved in AD patients, insofar as their subjective valence and arousal ratings (Boller et al., 2002; Budson et al., 2004; Kensinger, Anderson, Growdon, & Corkin, 2004; Kensinger, Brierley, Medford, Growdon, & Corkin, 2002; Satler, Uribe, Conde, Da Silva, & Tomaz, 2010), electro-dermal responses (Hamann et al., 2000), attention distribution patterns in respect of emotional stimuli (LaBar, Mesulam, Gitelman, & Weintraub, 2000), intentional use of suppression of expressed emotion (Henry, Rendell, Scicluna, Jackson, & Phillips, 2009), and differential reactivity to failure-versus-success tasks, in terms of both self-reports and facial expressions (Mograbi, Brown,