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Neurobiology of Aging 25 (2004) 1117–1124

NEUROBIOLOGY OF AGING

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Age related changes in emotional memory

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Received 3 April 2003; received in revised form 4 September 2003; accepted 27 October 2003

Abstract

Studies have found that emotionally evocative stimuli are better remembered than neutral stimuli, an effect called "emotional enhancement". Researchers have also found that the elderly experience an overall decline in memory relative to the young. We hypothesized that the elderly may experience diminished emotional enhancement, and that this may be one factor contributing to overall memory decline in the elderly. We tested elderly and young subjects on tasks of emotional memory for words and faces. In both the elderly and young, a shift in memory favoring positive stimuli (as opposed to negative and neutral stimuli) was evident, this effect being slightly more marked in the elderly. We suggest that the effects seen in both groups may be due to a shift from the amygdala-hippocampal system to the prefrontal cortex over time. We suggest that the more marked response in the elderly may be due to age-related changes in these brain systems, causing a further shift towards memory for positive material.

Keywords: Age; Emotion; Memory

1. Introduction

A decline in memory is a hallmark of aging [15,16,41,44]. The exact mechanisms of this decline are not known. However, in both animals and humans the emotional content of information can significantly influence the likelihood that it is remembered (animal studies: e.g., [14,48]; human studies: e.g., [16,25,26,41,51]. Emotionally evocative information is more likely to be recalled than emotionally neutral information. We refer to this effect as emotional enhancement. Both the level of stimulus-induced arousal and the valence of stimuli (negative versus positive) may play a role in the enhancement of memory. Loss of emotional enhancement with aging could be one mechanism that limits memory in the elderly. Lifestyle changes [12,13,21,36,51], sensory deficits [35,38,46] and atrophy of brain systems responsible for memory [52,53,57] all might affect the way individuals perceive and remember emotional information. The present study examines whether age affects perception and memory for emotional information that varies on the basis of valence.

Recent studies have isolated some of the brain systems involved in memory for emotional information (for review, see [34]). For instance, human imaging studies [3,11,26,28,40] and studies of amygdala damage in both human [1,6,32,33] and animal models [2,39,59] have shown that the amygdala contributes to emotion discrimination and emotional memory. Additionally, studies have shown that frontal regions may be important for the perception of emotional stimuli (e.g., [37]). This is particularly true in the elderly, who show greater frontal activation than their younger counterparts in tasks of emotion discrimination [22].

The prefrontal cortex [45,47], amygdala [31,49,57] and hippocampus [29,50], show atrophy even in apparently cognitively intact healthy elderly. We asked participants to complete tasks similar to those used in studies of these neural systems in order to study emotional enhancement in both elderly and young adults. Assuming age-related atrophic changes diminish the emotional enhancement effect in the elderly, we expected to see differences between the elderly and the young on emotional memory tasks.

Emotional stimuli can be from any modality and of many stimulus types (auditory, visual, faces, words, pictures, stories). Whether all would be equally affected by aging is unknown. As an initial probe of the breadth of age effects, we

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doi:10.1016/j.neurobiolaging.2003.10.015

Table 1
Participant demographics

	Older participants ($n = 36$)	Younger participants ($n = 25$)
Age (years)[a]	72.3 (63–81)	23.9 (18–35)
Education (years)	14.9 (10–22)	14.9 (13–17)
Men/women	13/23	11/14
WAIS-R vocabulary[b]	52.3 (36–65)	50.0 (40–61)
GDS[a]	2.5 (0–7)	5.8 (0–10)

Note: Range is shown in parentheses.

[a] $P < 0.001$; older subjects averaged fewer items (e.g., were less depressed), although GDS scores were all within the normal range.

[b] Raw scores.

examined two different kinds of stimuli (faces and words). Both of these kinds of stimuli have been shown to elicit activation in the frontal regions of the brain, the amygdala and the hippocampus during perception or memory tasks (words: [5,9,23,54,55] faces: [10,17,23,24,60,61].

Thus, in this study, we look at the impact of age on both the perception of emotional stimuli and the emotional enhancement of memory. We expected that the elderly would show a loss of emotional enhancement as compared to the young.

2. Method

2.1. Participants

Participants were 36 elderly adults and 25 young adults, recruited from an urban population (see Table 1). Participants were recruited through posted advertisements and a database of previous study participants. Medical histories were obtained via phone interview or in person. Inclusion criteria required that individuals be between 18 and 100 years of age (no one over 85 years of age was recruited), understand English, and have adequate hearing and vision to view computer and paper-pencil tasks (with correction if necessary). Elderly and young participants were matched for education level, and performance on the vocabulary sub-test of the Wechsler Adult Intelligence Scale-Revised (WAIS-R, [56]). This sub-test provides a standardized approximation of functional intelligence [56]. The vocabulary sub-test controls for cohort-related differences in educational environments and is highly correlated with both verbal and full-scale IQ scores.

All subjects were healthy. Exclusion criteria included a history of neurological problems (e.g., stroke, seizure, or head trauma), significant medical problems (e.g., uncontrolled hypertension) and psychiatric conditions (e.g., schizophrenia) or current use of medications likely to affect cognition such as anti-anxiety agents (e.g., prozac). The Mini-Mental Status Examination (MMSE, [20]) and Geriatric Depression Scale (GDS, [62]) were used to exclude participants with dementia (MMSE < 26—elderly subjects only) or depression (GDS > 10—both age groups). The GDS was used solely as a screening measure, and not as a variable for analysis. Because we used it to exclude elderly, we also used the same cut-off score to exclude younger subjects. However, the GDS is not normalized for younger subjects and the meaning of higher or lower scores as compared to the elderly is unclear. All subjects included in the study had scores within the normal range. Four additional subjects (two elderly, two young) were excluded from analysis due to high GDS scores (>10). All participants provided written informed consent, and were paid for their involvement in the study.

2.2. Procedures

2.2.1. Word rating, recall and recognition

Participants rated a list of words identical to that used in a previous study of emotional memory [42]. The list consisted of 27 words divided into three categories intended to elicit negative, neutral and positive affective valence ratings (nine words in each group). Words were matched among valence categories for frequency and word length [42]. Participants were asked to rate their feelings about each word on a five-point Likert scale (1 = negative, 3 = neutral, 5 = positive). Before beginning the task, the experimenter rated three example words (storm = 2, table = 3, motherhood = 5) to demonstrate the use of the rating scale. Participants then viewed the list of words, and circled the number on the adjacent 1–5 scale that best described their feelings about each word. Participants were not told that they would be asked to remember the words later.

Immediately after completing the word ratings, and again 30 min later, participants verbally recalled as many words as possible from the previously presented word list. After each recall, subjects were not told which answers were correct or incorrect. Following the second recall test, participants were given a written yes/no recognition test for the words. They were presented with a 54-word list; composed of the 27 target words rated earlier and 27 distracter words. The target and distracter words were matched for frequency, word length and emotional valence.

2.2.2. Face rating and recognition

During the 30-min retention interval between the word rating and the second word recall test, participants viewed and rated the valence of a series of 28 faces presented individually on a computer screen. Participants were asked to rate the faces on the same five-point scale as used with the words. Participants were not told that they would be asked to remember the faces later. The faces were drawn from the standardized set by Ekman and Friesen [18], and included four males and two females expressing a variety of emotions (happy, neutral, fearful, angry, sad, disgusted, surprised, disapproving). The face of each person was shown 4–6 times, each time expressing a unique emotion (making up the 28 face images). The images were grayscale, and