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Short title: autobiographical memory

"La vie en rose": a positive shift of autobiographical memory in Alzheimer's Disease

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Abstract

We investigated emotional regulation of autobiographical memories in Alzheimer 's disease (AD). AD patients and control participants were asked to retrieve memories in response to "happy" and "sad" cues. Participants were also asked to rate the emotional valence of memories at retrieval as well as at the moment the events were encoded. Results showed that both control participants and AD patients rated memories cued by "happy" as more positive when retrieved than when encoded. Both control participants and AD patients also rated memories cued by "sad" as less negative when retrieved than when encoded. Furthermore, emotional regulation (i.e., emotional variation across retrieval and encoding of memories) was significantly correlated with depression in AD patients and control participants. These findings suggest a cognitive reappraisal strategy by which AD patients 1) attribute positive meaning to positive memories, and 2) view negative emotional memories from a less negative perspective, demonstrating an ability to re-interpret the meaning of these memories, and thereby, to change their emotional impact. This reappraisal strategy seems to be related with depression as depressive symptoms was inversely correlated with cognitive reappraisal in AD.

Key words: Alzheimer's disease; autobiographical memory; cognitive reappraisal; emotion; emotional regulation

1. Introduction

Autobiographical memory or memory for personal information (Conway, 2005; Rubin, 2005) has been found to be compromised in Alzheimer's disease (AD), and this compromise is thought to induce a diminished sense of self and identity in the disease (Addis & Tippett, 2004; El Haj, Antoine, Nandrino, & Kapogiannis, 2015; Klein, Cosmides, & Costabile, 2003; Martinelli, Anssens, Sperduti, & Piolino, 2013). Although there is a considerable body of literature that focuses on the impairment of autobiographical specificity (Barnabe, Whitehead, Pilon, Arsenault-Lapierre, & Chertkow, 2012; El Haj, Antoine, & Kapogiannis, 2015a; El Haj, Antoine, Nandrino, Gely-Nargeot, & Raffard, 2015; Irish, Lawlor, O'Mara, & Coen, 2011; Muller et al., 2013; Seidl, Lueken, Thomann, Geider, & Schroder, 2011), relatively little is known about emotion regulation (i.e., strategies that are used to maintain, reduce, or even increase an emotion) of autobiographical memory in AD.

Emotional autobiographical memories, such as the first day in a new job, a holiday, first meeting with a partner, a major argument, or a loss of a loved one, play an important role in the construction of personal identity, and these memories are a key component in personal emotional well-being. On a clinical level, excessive focus on the unpleasant aspects of autobiographical memories can lead to affective disorders, such as depression and post-traumatic stress disorder (Brewin, Reynolds, & Tata, 1999; Joormann & Gotlib, 2010; Rubin, Boals, & Berntsen, 2008; Rubin, Dennis, & Beckham, 2011). To avoid these consequences, one should be able to control their emotional states by switching focus away from negative emotional aspects of some memories. This emotional regulation can occur thanks to cognitive reappraisal, a mechanism that refers to the reinterpretation of emotional information so as to alter its impact (John & Gross, 2004). Cognitive reappraisal has been known to be effective in reducing behavioral emotion

ratings as well as physiological responses to emotional information (Mauss, Cook, Cheng, & Gross, 2007). This emotional strategy has also been associated with subjective well-being (McRae, Jacobs, Ray, John, & Gross, 2012). The relationship between autobiographical memory and emotional regulation can be further viewed in light of the model of Conway (2005), according to which the retrieval of autobiographical memories is malleable and open to modulation by personally-relevant goals as well as emotional states.

As for emotion and memory in AD, studies have mainly investigated the effect of emotion on item memory. In a study on this topic (Sundstrøm, 2011), AD participants were asked to retain both neutral and emotional self-related items (i.e., gifts to the participants). Results showed a better recall for emotional than for neutral items. In another study (Kalenzaga, Bugaiska, & Clarys, 2013), AD patients rated neutral and emotional adjectives describing themselves; better memory was observed for emotional than for neutral adjectives. The effect of emotion has been also observed for implicit memory in AD. For instance, patients can implicitly remember emotional information despite forgetting the circumstances in which this information has been retained, this assumption can be supported by a study case reporting a patient who displayed persistent dislike for a physician after a negative experience at an appointment, even though the patient could not recall the specific experience (Evans-Roberts & Turnbull, 2011). Few studies have however investigated the effect of emotion on autobiographical memory in AD. Philippi et al. (2015) asked AD patients and control participants to produce specific memories in response to cues (e.g., letter, train, surprise, among others). Results showed that in both groups, although AD patients elicited less emotional memories than the controls, emotional memories were more specific than neutral ones. In another study on emotional characteristic of autobiographical memory, Melendez, Escudero, Satorres, and Pitarque (2019) invited AD

patients and control participants to retrieve memories cued by words with a positive valence (e.g., happiness, friendship, smile) or a negative valence (e.g., sadness, illness, worry). Results demonstrated fewer emotional memories in AD patients compared with control participants. The emotional characteristic of autobiographical memory in AD has been investigated in another study in which AD participants were asked to rate, after autobiographical retrieval, the phenomenological characteristics of their memories (e.g., reliving, back in time, remembering, realness, visual imagery, auditory imagery, emotion, importance) (El Haj, Kapogiannis, & Antoine, 2016). Emotion was evaluated by asking participants to rate, after autobiographical retrieval, the following item "can feel now the emotions I felt then". Results showed low rating for phenomenological characteristics in AD patients, except for emotion and importance.

The emotional characteristics of autobiographical recall in AD can be better understood by evaluating how the patients define these characteristics during encoding and retrieval of the events. This evaluation may reveal not only whether autobiographical memory recall elicits positive or negative emotions, but also whether AD patients can regulate emotional responses in a way that helps them control and manage negative emotions that are elicited by memories. One expectation would be that based on the occurrence of depression in AD, especially in the mild stages of the disease when patients can be aware of their failing cognitive capacities, AD patients may attribute negative valence to their retrieved memories, (Geerlings et al., 2000; Gormley & Rizwan, 1998). On the other hand, one may expect that AD patients employ successful emotional regulation and thus attribute some positive meaning to negative memories. This view can be supported by the Socio-emotional Selectivity Theory (Carstensen, Isaacowitz, & Charles, 1999; Carstensen et al., 2011), according to which older adults demonstrate high levels of emotional stability and successful emotional regulation. More specifically, as older adults begin

to view their lifetime as limited, they tend to show an increased motivation to process positive emotional stimuli and to evoke emotional regulation processes in favor of a maximization of positive compared to negative information, a mechanism that has been referred to as an age-related "positivity effect" (Carstensen et al., 1999; Carstensen et al., 2011).

To assess how AD patients would regulate emotional experiences of autobiographical memory retrieval, we asked AD patients and controls to retrieve memories in response to the cues "happy" and "sad". After each memory event, participants were asked to rate its emotional valence (i.e., very negative, negative, somewhat negative, neutral, somewhat positive, positive, very positive) in the present as well as at the moment the event was encoded. We calculated emotional regulation scores as follows: emotional valence of memories cued by "happy" at retrieval minus rating of emotional valence of these memories at encoding, we also applied the same calculation for memories cued by "sad". We finally assessed the relationship between emotional regulation and depression. We expected that AD patients would rate memories cued by "happy" as more positive when retrieved than when encoded. We also expected significant correlations between emotional regulation and depression.

2. Method

2.1. Participants

Twenty-eight participants with a clinical diagnosis of probable mild AD (20 women and 8 men; *M* age = 71.71 years, *SD* = 5.12; *M* years of formal education = 8.75, *SD* = 2.32) and 30 control older adults (19 women and 11 men; *M* age = 68.80 years, *SD* = 8.01; *M* years of formal education = 9.27, *SD* = 2.47) voluntarily participated in the study. The AD participants were

recruited from local retirement homes. Probable AD diagnosis was made by an experienced neurologist or geriatrician according to the criteria developed by the National Institute on Aging and the Alzheimer's Association criteria for probable Alzheimer's disease (McKhann et al., 2011). The control participants were recruited from the local community and were independent and living at home. These participants were matched with the AD patients according to age [$t(56) = 1.62$, $p > .10$], sex [X^2 (1, $N = 58$) = .43, $p > .10$] and educational level [$t(56) = .82$, $p > .10$].

The exclusion criteria for all participants were a significant neurological or psychiatric illness and alcohol or drug use. No participants presented any major visual or auditory acuity difficulties that could prevent assessment. They freely consented to participate and were able to withdraw whenever they wished. Of the 35 AD participants originally recruited, three participants were excluded for aphasic deficiencies preventing communication, two participants were excluded for difficulties generating memories to the “sad” cue, and the data related to two other participants were corrupted. Thus, our final sample included 28 patients with AD, as mentioned above.

2.2. Instruments

2.2.1. Cognitive assessment

Cognitive characteristics of all participants were evaluated with a battery assessing general cognitive functioning, episodic memory, spans, and depression. Scores are summarized in Table 1.

General cognitive functioning was assessed with the Mini Mental State Exam (Folstein, Folstein, & McHugh, 1975) and the maximum score was 30 points. Episodic memory was assessed with a French version (Van der Linden et al., 2004) of the episodic task of Grober and Buschke (Grober & Buschke, 1987) in which the participants had to retain 16 words, each describing an item belonging to a different semantic category. Immediate cued recall was succeeded by a distraction phase during which participants had to count backwards from 374 in 20 s. This distraction phase was succeeded by two minutes of free recall and the score from this phase provided a measure of episodic recall (16 points maximum). In spans assessment (digit span tasks), participants were asked to repeat a string of single digits in the same order (i.e., forward spans) or in reverse order (i.e., backward spans).

2.2.2. Depression

We evaluated depression with the Hospital Anxiety and Depression Scale (Zigmond & Snaith, 1983) which consists of seven items that were scored by participants on a four-point scale ranging from 0 (not present) to 3 (considerable). The maximum score of depression was 21 points, as recommended by Herrmann (1997), the cut-off for anxiety and depression was set at > 10/21 points.

Table1.

Cognitive characteristics of Alzheimer's disease (AD) patients and control participants

	Task	AD *n* = 28	Older adults *n* = 30
General Cognitive functioning	Mini-Mental State Examination (MMSE)	21.50 (1.86)***	27.73 (1.55)
Episodic memory	Grober and Buschke	5.79 (2.39)***	11.07 (2.91)
Spans	Forward span	5.39 (1.29)***	6.80 (1.58)
	Backward span	3.64 (1.20)*	4.80 (1.58)
Depression	HADS	7.96 (2.12)***	6.13 (2.28)

Note. Standard deviations are given between brackets. The maximum MMSE score is 30 points; the maximum score on the Grober and Buschke task is 16 points. The performance on the forward and backward spans refer to number of correctly repeated digits. The maximum score on the HADS (Hospital Anxiety and Depression Scale) is 21 points. Differences between groups were significant at: $^{*}p < .05$, $^{***}p < .001$.

2.2.3. Autobiographical memory

Participants were asked to recount in detail an event in their life to the cues "happy" and "sad". Participants were allowed three min to describe their memories, and the duration was made clear to them so that they could structure, so much as possible, their memories accordingly. This time limit was implemented to avoid redundancy or distractibility and was found to be sufficient for autobiographical recollection in individuals with AD (El Haj, Antoine, &

Kapogiannis, 2015a, 2015b). After retrieval, we assessed the emotional characteristics of memory by asking participants to rate on a seven-point scale (-3 = very negative, -2 = negative, -1 = somewhat negative, 0 = neutral, 1 = somewhat positive, 2 = positive, 3 = very positive) the emotional valence of their memories at retrieval as well as at the moment the event occurred. Emotional ratings for retrieval and encoding were counterbalanced across participants. However, all participants reported memories to the cue "sad" then "happy"; these conditions were not counterbalanced for ethical reason, that is, that the participants end the experiment with a positive rather than a negative state. Similarly, the participants were debriefed after the experiment and were invited to expand on any affective issue. It is worth noting that we used the cues "happy" and "sad" rather than "positive" and "negative", respectively, as some AD patients, on an independent pilot sample, had difficulties understanding the emotional meaning of both "positive" and "negative" cues.

2.2.3.1. Autobiographical specificity

Besides the evaluation of emotion, as rated by the participants, we assessed autobiographical specificity with a four-point scale (zero points = absence of memory or only general information, one point = repeated/extended event without spatiotemporal details, two points = repeated/extended event with spatiotemporal details, three points = events lasting less than a day with spatiotemporal details, four = events lasting less than a day with spatiotemporal and phenomenological details). This scale was based on the Autobiographical Memory Interview (Kopelman, Wilson, & Baddeley, 1989) and the Test Episodique de Mémoire du Passé (Piolino, Desgranges, Benali, & Eustache, 2002)). To avoid a bias in scoring, a second independent rater rated a random sample of 20% of the data; an inter-rater correlation (agreement) coefficients of

0.82 and higher was obtained (Shrout & Fleiss, 1979). Cases of disagreement were discussed until a consensus was achieved.

3. Results

3.1. Analysis

We first compared the differences on autobiographical specificity between AD participants and older adults in memories cued by "happy" and "sad". We then compared differences on the emotional rating between AD participants and older adults and within each population. Owing to abnormal distribution of data, non-parametric tests were conducted. Between-group comparisons were performed using the Mann-Whitney U test and within-group comparisons were performed using the Wilcoxon signed rank test. We also assessed, for each population, correlations between depression and emotional regulation scores (i.e., differences between emotional ratings during retrieval and encoding). For all tests, the level of significance was set as $p \leq 0.05$, p values between 0.051 and 0.99 were considered as trends, if any. Significant results were provided with effect size: $d = .2$ can be considered a small effect size, $d = .5$ represents a medium effect size and $d = .8$ refers to a large effect size (Cohen, 1988). Note that the effect size was calculated for non-parametric tests following recommendations by Rosenthal and DiMatteo (2001), and Ellis (2010).

3.2. Low autobiographical specificity in AD participants

Specificity scores are depicted in Figure 1. Analyses showed lower specificity in AD patients than in control participants for memories cued by "happy" ($Z = -3.48$, $p < .001$, $d = 1.02$), and those cued by "sad" ($Z = -3.32$, $p = .001$, $d = .97$). Similar specificity was observed for

memories cued by “happy” and those cued by “sad” in AD patients (Z = -1.13, $p > .1$, $d = .30$) and control participants (Z = -1.00, $p > .1$, $d = .26$).

[INSERT FIGURE 1 APPROXIMATELY HERE]

3.3. More positive and less negative emotion for retrieval than for encoding in AD

Emotional ratings for memories cued by “happy” and “sad” in AD patients and controls are depicted in Figure 2. AD patients rated memories cued by “happy” as more positive when retrieved than when encoded (Z = -2.78, $p < .01$, $d = .78$), and the same thing was observed for the control participants (Z = -2.65, $p < .01$, $d = .74$). AD patients rated memories cued by “sad” as less negative when retrieved than when encoded (Z = -4.30, $p < .001$, $d = 1.36$), and the same thing was observed in the control participants (Z = -3.88, $p < .001$, $d = 1.18$). AD patients and control participants attributed similar emotional valence for memories cued by “happy” at retrieval (Z = -.34, $p > .1$, $d = .09$) as well as at encoding (Z = -.17, $p > .1$, $d = .04$). AD patients and control participants attributed similar emotional valence for memories cued by “sad” at retrieval (Z = -.33, $p > .1$, $d = .08$) as well as at encoding (Z = -1.13, $p > .1$, $d = .30$).

[INSERT FIGURE 2 APPROXIMATELY HERE]

3.4. Significant correlations between emotional regulation and depression in AD

We calculated emotional regulation scores as follows: emotional valence of memories cued by “happy” at retrieval minus rating of emotional valence of these memories at encoding. We also applied the same calculation for memories cued by “sad”. By doing so, we obtained an index of emotional variation between retrieval and encoding of memories. We then assessed the correlations between emotional regulation and depression in each population. As shown in Figure 3, significant negative correlations were found between emotional regulation and

depression for memories cued by “happy” and those cued by “sad” in AD patients. As shown in Figure 4, significant negative correlations were also observed between emotional regulation and depression for memories cued by “happy” and those cued by “sad” in the control participants.

4. Discussion

This study investigated whether AD patients would regulate emotional valence of autobiographical memories across encoding and retrieval. Analysis showed that both control participants and AD patients rated memories cued by “happy” as more positive when retrieved than when encoded. We also found that control participants and AD patients rated memories cued by “sad” as less negative when retrieved than when encoded. Emotional regulation (i.e., emotional variation across retrieval and encoding of memories) was significantly correlated with depression in AD patients and control participants.

Before turning to our core findings, we will first highlight that lower autobiographical specificity was observed in AD patients than in control participants, regardless of the emotional valence. These findings fit with a body of literature showing a decrease in autobiographical specificity in AD (Barnabe et al., 2012; El Haj, Antoine, & Kapogiannis, 2015a; El Haj, Antoine, Nandrino, Gely-Nargeot, et al., 2015; Greene, Hodges, & Baddeley, 1995; Irish et al., 2011; Melendez et al., 2019; Muller et al., 2013; Seidl et al., 2011). This literature demonstrates that AD hinders autobiographical retrieval by lowering the production of specific memories or events that occurred at specific times and locations. According to the Autobiographical Memory in Alzheimer’s Disease model (El Haj, Antoine, Nandrino, & Kapogiannis, 2015), a decrease in autobiographical specificity in AD results in a de-contextualization of memories and a shift from the ability to mentally relive past events (i.e., autonoetic consciousness) to a general sense of familiarity which, itself, also declines with AD (Pitarque et al., 2016).

Although our AD patients demonstrated a diminished autobiographical specificity, they have shown an emotional regulation strategy by which positive emotional valence of memories increased between encoding and retrieval. Memories cued with “happy” were rated as more positive during retrieval than during encoding, and the same thing was observed for memories cued by “sad”. In our view, this pattern reflects a successful emotional regulation by which positive past experiences are attributed more positive meaning, and negative past experiences are integrated into a less negative re-evaluation, probably because these negative experiences are integrated within the self-schema. In other words, it is likely that AD patients use both negative and positive past memories to derive some strengths from these experience and cope with life stressors (e.g., the diagnosis, the hospitalization). This finding is in agreement with the Socio-emotional Selectivity Theory (Carstensen et al., 1999; Carstensen et al., 2011), according to which (normal) aging is characterized by a selective inhibition of negative information and a disproportionate preference for positive information. Since the Socio-emotional Selectivity Theory has been mainly assessed in normal aging, our findings may be considered as an extension of this theory on autobiographical memory AD. At the clinical level, our findings are important as they demonstrate that AD patients may succeed to retrieve their memories in a fashion allowing successful integration of negative memories into their life story. More specifically, our findings may provide a positive view of reappraisal strategies in AD patients who typically duffer poor levels of resilience and orientation toward problem-solving as well as low wellbeing (Meléndez, Satorres, Redondo, Escudero, & Pitarque, 2018).

The findings that AD patients attribute more positive meaning for past experiences and less negative meaning for negative past experiences can be also considered as an extension of the Fading Affect Bias. This bias refers to the fact that the affective state associated with negative

memories typically tends to fade faster than the affective state associated with positive memories (Cason, 1933; Lindeman, Zengel, & Skowronski, 2016). The Fading Affect Bias has been observed across a variety of positive and negative emotions (Ritchie, Skowronski, Hartnett, Wells, & Walker, 2009), and has been found to occur regardless of whether the event-related emotions were active (e.g., elated, angry) or passive (e.g., calm, sad). Furthermore, this bias seems to persist over long periods of time, a diary study has demonstrated that this bias emerged within 24 hours after event encoding and remained stable for at least three months (Gibbons, Lee, & Walker, 2011). According to Walker, Vogl, and Thompson (1997), the Fading Affect Bias allows individuals to view their lives as pleasant by retaining positive emotions and minimizing negative emotions. Thus, this bias can be considered as a healthy coping mechanism operating in human memory. Although the Fading Affect Bias has been assessed across cultures (Ritchie et al., 2015), there is, to the best of our knowledge, no published study on this effect in AD. Our results can thus be considered as providing some support for this bias in AD. However, note that in typical research on the Fading Affect Bias, participants report the first emotional characteristics directly after the events occurrence, and not after long delay as in our study.

Our analysis demonstrated significant negative correlations between emotional regulation and depression in both AD patients and control participants. In other words, the more participants showed depression, the lesser their emotional regulation was. Depression has been widely associated with impaired emotion regulation and persistent negative affect. Moreover, reduction in positive affect has been considered as one of the hallmark features of depression (Joormann & Gotlib, 2010). In line with this consideration, studies demonstrate a frequent use of certain emotional strategies (e.g., thought suppression, rumination, catastrophizing) and a little use of successful emotional strategies (e.g., reappraisal, self-disclosure) in depression and

anxiety (Campbell-Sills, Barlow, Brown, & Hofmann, 2006; Garnefski & Kraaij, 2006; Gross & John, 2003). Also, emotional avoidance can be associated with autobiographical overgenerality. According to the CaRFAX model (Capture, Rumination, Functional Avoidance, EXecutive Functioning) (Williams, 2006), autobiographical overgenerality can be attributed to executive dysfunction and avoidance of emotions. In other words, autobiographical overgenerality can be attributed to functional avoidance strategies in the sense that stopping memory retrieval at a general level rules out access not only to specific memories but also to the emotional charge that is associated with them (Dalgleish, Rolfe, Golden, Dunn, & Barnard, 2008; Williams et al., 2007). In our study, participants demonstrated a cognitive reappraisal strategy by which they deliberately viewed negative emotional memories from a less negative perspective, demonstrating an ability to re-interpret their meaning, and thereby, to change their emotional impact. This strategy seems to be related to depression as (AD and controls) participants with more severe depressive symptoms demonstrated low cognitive reappraisal and vice-versa.

Like AD patients, our control participants demonstrated similar cognitive reappraisal. Although autobiographical memories generated by older adults have been found to contain less specific details and more generic content than those remembered by younger adults (Levine, Svoboda, Hay, Winocur, & Moscovitch, 2002; Piolino et al., 2010), older adults tend to report more collective experience during autobiographical recall (Janssen, Rubin, & St Jacques, 2011) (Janssen et al., 2011). Interestingly, one study has found that older adults retrieved fewer specific memories than younger adults, a decline that was observed for neutral cues, but not for positive or negative ones (Holland, Ridout, Walford, & Geraghty, 2012). Hence, older adults seem to demonstrate important recall for emotional autobiographical memories. In our study, older adults demonstrated similar specificity for both memories cued by “happy” and “sad”, probably due to

emotional stability and successful emotional regulation by which negative memories are successively integrated within their self-schema (Carstensen et al., 2011).

One shortcoming of our study is the absence of assessment of neutral memories. Such an assessment may allow us to investigate whether AD patients can attribute affective meaning to neutral memories. It is worth noting, however, that neutral memories can evoke considerable affective content, at least as observed in normal populations (El Haj, Antoine, & Nandrino, 2016), and thus should be used with caution. Another shortcoming of our study is the small sample size which may led to the study being underpowered and increases the risk of a type II error.

To summarize, despite a decrease in autobiographical specificity, AD patients seem to retrieve their memories in a fashion allowing successful integration of negative memories into their life story. These patients also seem to increase valence of their positive memories, probably to reflect satisfaction with life and achievement of personal goals.

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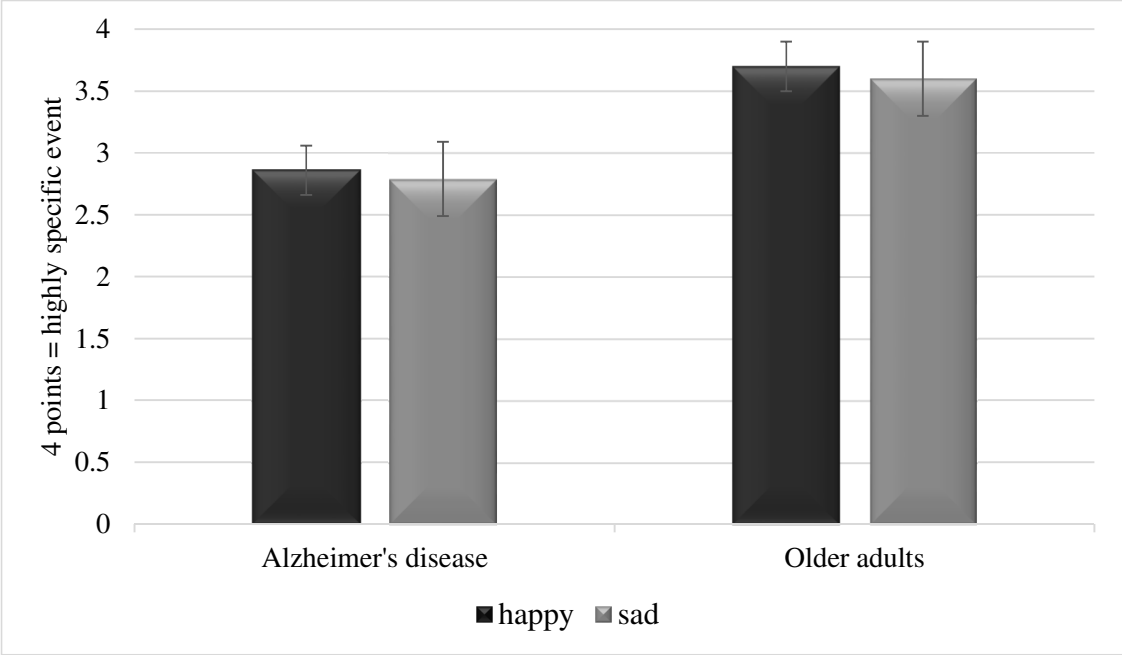


Figure 1:
Specificity scores for memories cued by “happy” and “sad” in Alzheimer’s disease patients and controls. Error bars represent intervals of 95 % within-subjects confidence

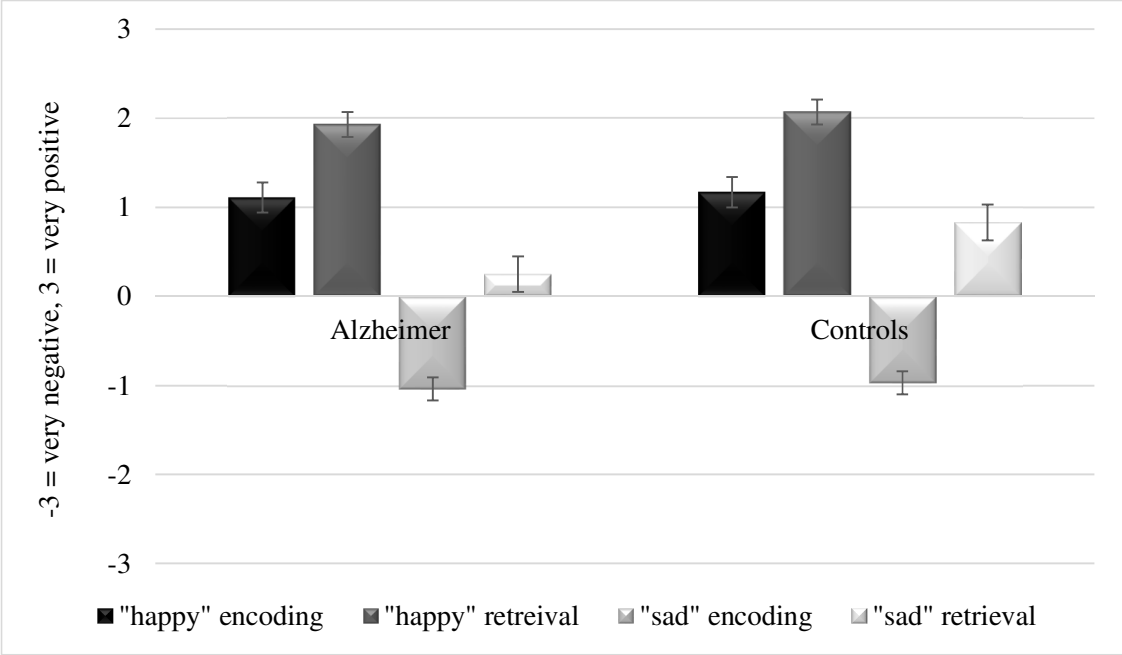
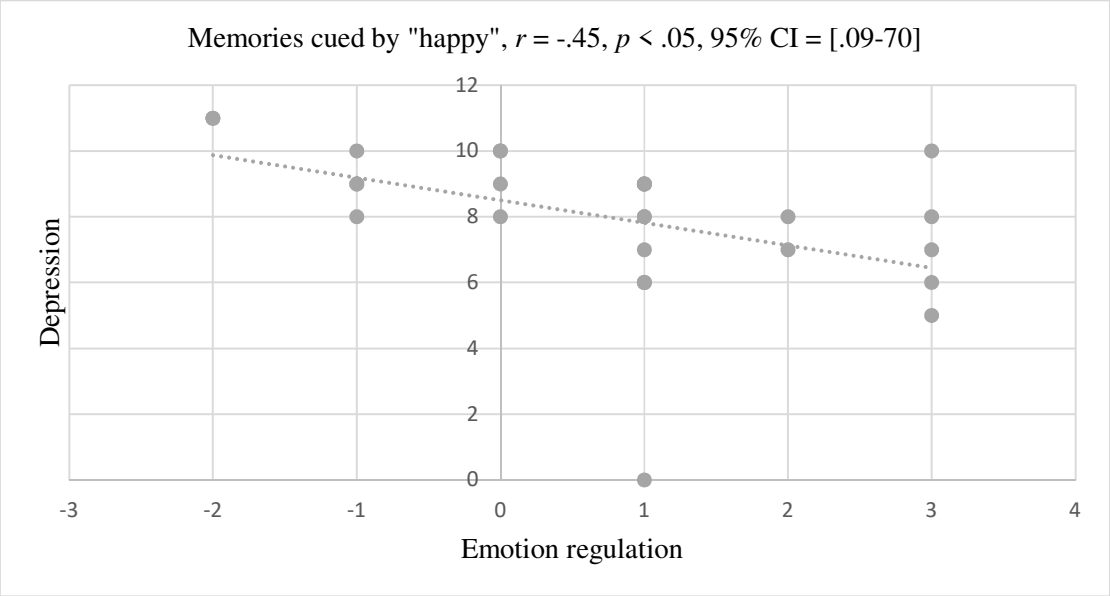


Figure 2:
Emotional ratings for memories cued by “happy” and “sad” in Alzheimer’s disease patients and controls. Error bars represent intervals of 95 % within-subjects confidence



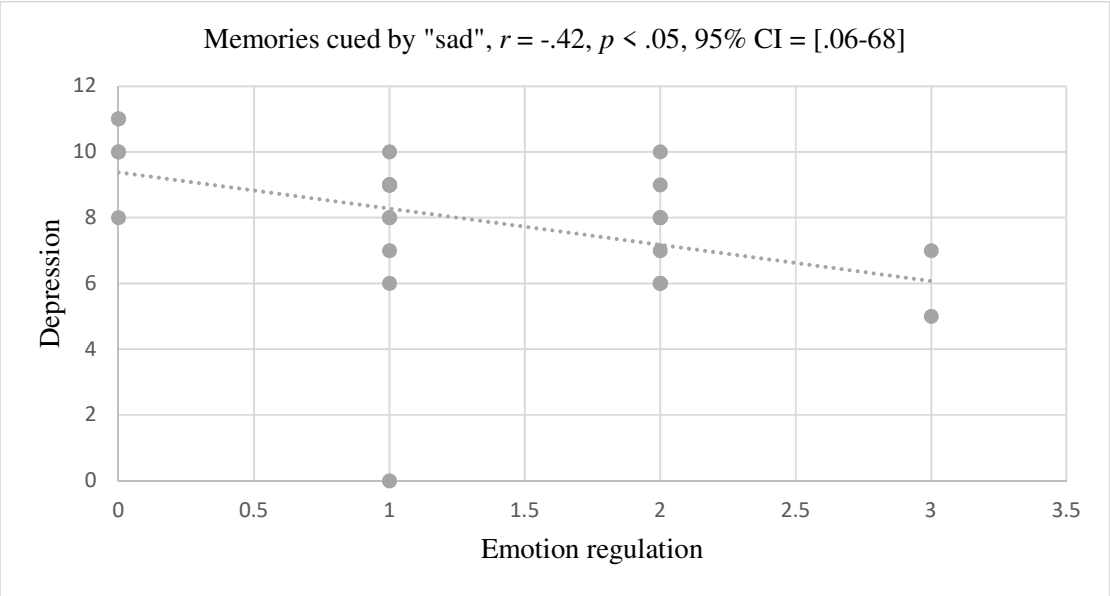
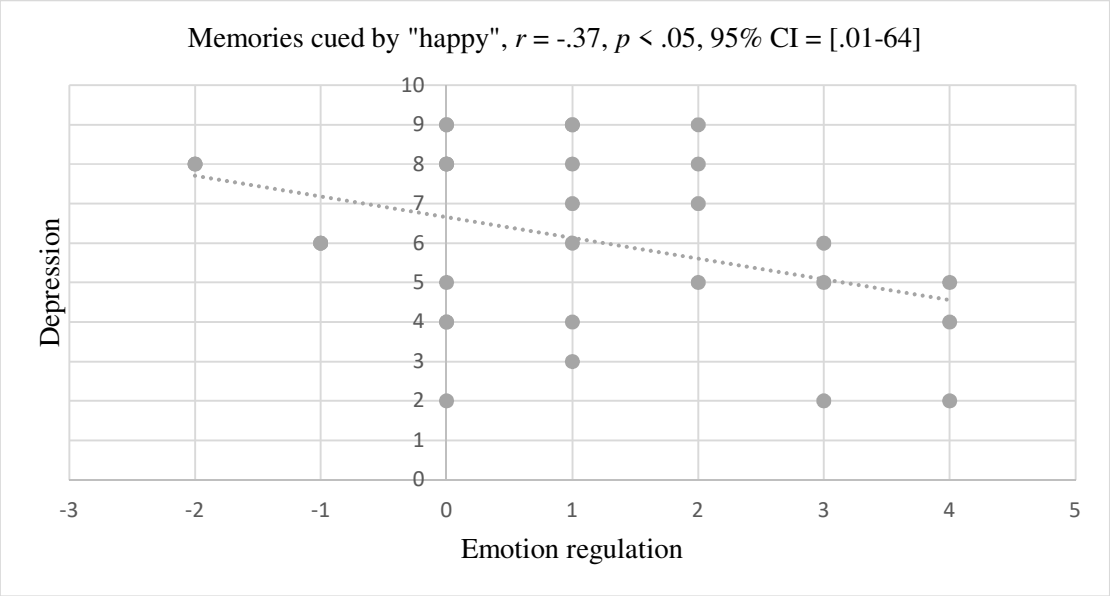


Figure 3:
Correlations between emotional regulation and depression for memories cued by “happy”, and those cued by “sad” in patients with Alzheimer’s disease.
Note. *The maximum score was 21 points. Emotional regulation scores referred to: emotional valence of memories at retrieval minus rating of emotional valence of these memories at encoding.*



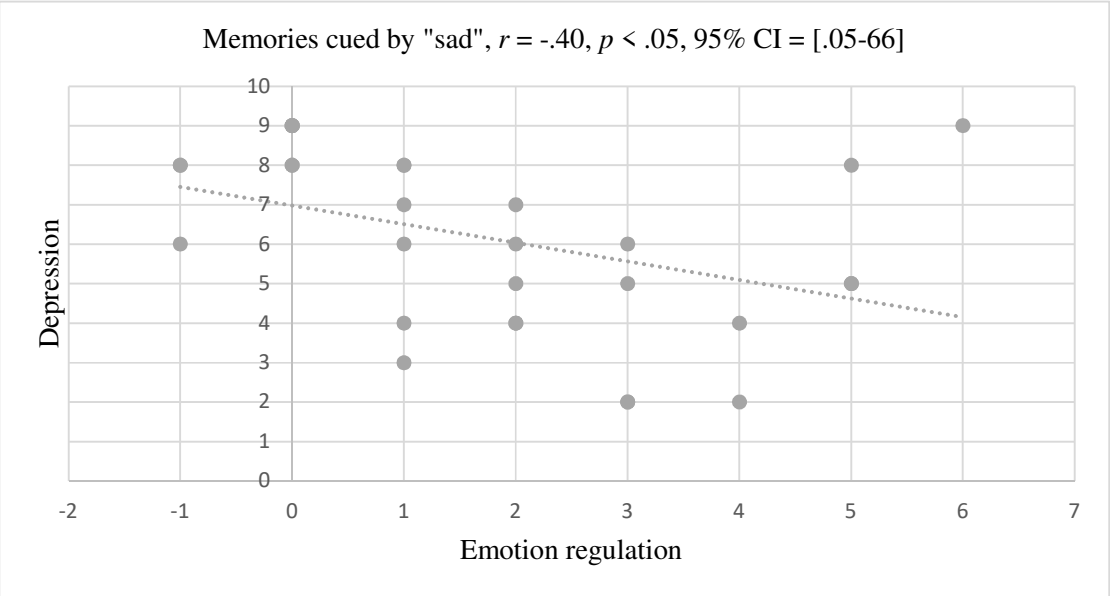


Figure 4:
Correlations between emotional regulation and depression for memories cued by “happy”, and those cued by “sad” in control participants.
The maximum score was 21 points. Emotional regulation scores referred to: emotional valence of memories at retrieval minus rating of emotional valence of these memories at encoding.