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ARE FLASHBULB MEMORIES PRESERVED IN ALZHEIMER'S DISEASE?

ALZHEİMER HASTALIĞINDA FLAŞBELLEK KORUNUYOR MU?

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Abstract

Alzheimer's Disease is a neurodegenerative disorder characterised by a progressive memory loss. However, it is not clear whether flashbulb memories- a subgroup of autobiographical memories with an emotional component- are influenced to the same extent in Alzheimer's Disease. In this study, we investigated flashbulb memory performances of 29 early stage Alzheimer's Disease patients as compared to healthy young controls. In addition, we measured the verbal memory performance of patients by using Verbal Memory Processes Test. Results showed that although the patient group displayed a significant impairment in verbal memory encoding, their flashbulb memory performance was not significantly different from healthy young controls. In conclusion, our study supports the notion that flashbulb memories can have a special neural network and suggests that flashbulb memories are preserved in early stage Alzheimer's Disease.

Keywords: alzheimer's disease, dementia, flashbulb memory, emotional memory

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Öz

Amaç: Alzheimer Hastalığı, ilerleyici bellek bozukluğuyla karakterize bir nörodejeneraitf hastalıktır. Fakat, otobiyografik belleğin bir alt grubu olarak kabul edilen ve emosyonel içeriği olan flaşbelleğin Alzheimer hastalığında aynı derecede etkilenip etkilenmediği yeterince açık değildir. Yöntem: Bu çalışmada, 29 erken evre Alzheimer hastalığı olan katılımcıların flaşbellek performansı incelenmiş ve sağlıklı genç yetişkinlerle karşılaştırılmıştır. Ek olarak, hasta grubunun sözel bellek performansı Öktem Sözel Bellek Süreçleri Testi kullanılarak ölçülmüştür. Sonuç: Yapılan analizler sonucuda, Alzheimer hastalığı olan grubun sözel bellek kayıt sürecinde anlamlı kayıp bulunmasına ragmen flaşbellek performansları açısından sağlıklı genç yetişkinler ile aralarında anlamlı fark bulunmamıştır. Tartışma: Sonuç olarak, bu çalışma flaşbelleğin özel bir nöral şebekeye sahip olduğu görüşünü destekleyerek, erken evre Alzheimer Hastalığında flaşbellek performansının korunuyor olabileceğini düşündürmektedir.

Anahtar Kelimeler: *alzheimer hastalığı, demans, flaşbellek, emosyonel bellek*

1. Introduction

Flashbulb memories (FBMs) are known as a subgroup of autobiographical memories, the representations of crucial traumatic experiences that are reserved in a thorough and eloquent way (Brown and Kulik, 1977; Pillemer, 1984). They are vivid and detailed memories persistent over time and creating strong emotional reactions. These memories are thought to mostly include unusual and shocking public events such as the September 11th attacks or the assassination of John F. Kennedy, as well as meaningful and extraordinary personal events that are separable from everyday memory such as a graduation ceremony, wedding day or a car accident. (Brown and Kulik, 1977).

Given the emotional component of FBMs, what makes the flashbulb memory "special" seems the emotional arousal induced by the event rather than the event itself. Accordingly, Cahill et al. (1995) suggested that improved long term memory is strongly associated with emotional arousal. Emotion is said to influence interpersonal processes and increase people's sharings of their personal experiences (Cahill et al., 1995); and the preservation of FBM is based on the commitment in pervasive rehearsal over time (Roehm, 2015). Nonetheless, it is important to note that there are noteworthy inconsistencies in most people's flashbulb memories despite their vivid nature. In a research conducted with 9/11 victims, it is concluded that 10 years after the event, the victims' memories were accurate by 60%. In the meantime, if someone suggested a false detail of the event into their memory, the detail is kept by the subject, instead of being corrected (Hirst et al., 2015).

Although very little is known about the neural pathways involved in recollection of FBMs, they can be considered as a form of episodic-emotional memory. Episodic memory is made up of individuals' unique memories that are gathered from specific events. Episodic memories are put in function by systems of the medial temporal lobe, along with the hippocampus. Systems within the medial temporal lobe and especially the hippocampus have specific functions in linking information from multiple cortical streams, aiding our ability to encode and retrieve details of events that make up episodic memories (Squire and Zola-Morgan, 1991; Lech and Susan, 2013). Thus, a damage in the medial temporal lobe, hippocampus and other components of the large-scale memory system jeopardizes the episodic memory, as it does in Alzheimer's Disease (AD) (Dickerson and Eichenbaum, 2010). Therefore, episodic memory is hypersensitive to the effects of aging and very contaminated by AD which eventually lead people to lose the memories of particular episode of their daily lives. (Tromp et al., 2016).

Flashbulb memories have not been studied well in AD; while plenty of studies are present in literature suggesting reduced emotional enhancement in memory encoding in AD as compared to non-demented older adults (Kensinger et al., 2002). Some reports, on the other hand, demostrated intact emotional memories with the patients of AD (Okada and Matsuo, 2012). However, how long the memory recollection for emotional experiences can last in these patients has not been well reported. Based on these findings, it's not completely clear if flashbulb memories are affected to the same extent as ordinary episodic memories in Alzheimer's disease. To test the integrity of emotional (i.e., flashbulb) memories in AD we evaluated this particular memory by applying patients the same episodic memory retrieval test immediately and 6 months after the coup attempt which happened on July the 15th 2016 in Turkey. We also tested patients using an extensive neuropsychological battery test to establish the diagnosis of probable AD. In addition to patients with AD, the same test was also applied to young individuals during the same period of time to compare their performance to AD patients. The research hypothesis is that the emotional memories are effected to a lesser extend than ordinary episodic memories in AD.

2. Materials and Methods

The ethics committee approval has been obtained from Uskudar University Non-Interventional Research Ethics Committee, report number of B.08.6.yök.2. üs.0.05.0.06/2017/76 (08 May 2017).

2.1. Participants

A total of 29 Turkish patients diagnosed with probable early-stage Alzheimer's disease (AD) according to the NINCDS-ADRDA criteria participated in the study (16 men, 13 women (McKhann et al., 1984). Participants were recruited from a nursing home in Istanbul. The mean MMSE score of patients was 24,00 ± 1,64 (minimum score:21, maximum score:26). The mean age of the patient group was 75±7,19 (range 61–87), and the mean education year was 4,45 ±2, 84 (range 1-11). A total of 18 college students without a history of neuropsychological disease were recruited to the study as a control group only for FBM assessment. The mean age of control group was 20,5 ±1,24 (range 19-23), and the mean education year was 15±1.24. The protocol was approved by the local ethics committee and all participants gave

informed consent. The consent was also taken from legal guardians of Alzheimer patients.

2.2. Procedure

On 15th July 2016 a coup attempt happened in Turkey and people witnessed soldiers shooting and blocking the roads, combat planes hovering low over the cities and bombing some of the public buildings. As these were highly shocking and traumatizing scenes, Turkish participants' recollections about 15th July coup attempt were evaluated to test their flashbulb memories. Patients were firstly tested in July 2016 following the attempt. The same participants were retested 6 months later the attempt, in February 2017.

2.3. Flashbulb memory assesment

The Flashbulb memory questionnaire was translated from "Rappel du 11 septembre 2001 et recherche d'un souvenir flash dans la maladie d'Alzheimer: Une aide à l'évaluation de la plainte mnésique en pratique courante, La Presse Médicale" (Anterion et al., 2007). Prior to test the FBM assessment, participants are firstly asked to report their basic knowledge about the 15th July coup attempt via the following questions: What is 15th July coup attempt?

Who made the coup attempt? Against whom was the coup attempt made? What happened as a result of coup attempt? In order to measure FBM, all participants had to answer 4 questions about the place (where were you at the time), the time (at what time of the day did you hear about the news), the activity (what were you doing), and the emotional arousal (how did you react: what did you do/what did you feel). For each question, they were also asked to rate themselves in terms of confidence in given answers on a 10-point rating scale (10:very confident, 1: not confident at all). The same procedure was applied 6 months later again.

Participants' FBM consistency to each question in the first and second assesment was assigned as either 0 or 1 (0: not consistent with previous answer, 1: consistent with previous answer). The total consistency level was measured by adding consistency scores of 4 FBM questions.

2.4. Mental examination and memory assessment

MMSE (Mini Mental State Examination): The Turkish version of MMSE was standardized by Gungen et al. (2002). The maximum score was 30 and it consisted of six subgroups measuring orientation, registration, attention, recall, language, and visuospatial functions (Folstein et al., 1975).

SBST (Sözel Bellek Süreçleri Testi: Verbal Memory Processes Test: VMPT): SBST is a 15 word Turkish verbal learning memory test developed by Öktem–Tanor (Tanor, 2011). Participants are read a list of 15-words for 10 times and in each repetition are asked to recall as many words as possible. After 40 minutes delay, they are asked to recall as many word as possible. As a final step, participants are asked to recognize the target word appeared on the list among 3 options. The test evaluates immadite recall, short term verbal memory, 40 min. delayed long term recall and long term recognition. At the end of test, participants are given an immediate recall score, a maximum short term learning score, a total learning score, a delayed recall score, a delayed recognition score and a total delayed memory score. In literature, total learning score and total delayed memory score are the mostly used scores of SBST to measure long term memory performance.

2.5. Activities of Daily Living (ADLs)

Activities of daily living can be defined as all basic self-care tasks and complex independent activities to sustain a healthy daily living. In this study, Katz Index of Independence in Basic Activities of Daily Living (BADL) and Lawton Instrumental Activities of Daily Living (IADL) Scale were used to assess basic and instrumental ADLs (Katz et al., 1963; Lawton&Brody, 1969).

Basic Activities of Daily Living scale consists of 6 self-care questions including feeding, grooming, bathing, dressing, toileting, and mobility. Scores range from 0-6: full functional impairment, 7-12: half functional impairment, 13-18 : no functional impairment.

Lawton Instrumental Activities of Daily Living scale consists of 8 independent living questions as shopping, driving, telephone using, meal preparation, finance management, taking medications and arranging appointments. Scores range from 0-8: full functional impairment, 9-16: half functional impairment, 17-24:no functional impairment.

2.6. Statistical Analysis

Independent samples t-test was used to examine group differences in flashbulb memory performance. Pearson correlation analysis was conducted to examine the relationship between FBM, SBST and ADLs scores. One sample t-test was used to compare SBST scores of AD patients with SBST scores of normal population. The significance level was set at $p < .05$, two tailed for all analyses.

3. Results

As expected, the immediate memory score ($M = 3.10 \pm 1.58$; $t(28) = -6.90$, $p < .01$), the maximum short term learning score ($M = 8.48 \pm 2.48$; $t(28) = -12{,}18$ $p < .01$), the total learning score ($M = 62.07 \pm 20.697$; $t(28) = -11.644$, $p < .01$), the delayed recall score ($M = 5.10 \pm 3.98$; $t(28) = -10.13$, $p < .01$) and the total delayed memory score ($M = 10.82 \pm 3.23$; $t(28) = -2.95$, $p < .01$) of patients on SBST were below the normal range of age-matched Turkish population ($M = 5.14 \pm 1.29$ for immediate memory score, $M = 14.11 \pm 1.06$ for maximum short term learning score, $M = 106{,}82 \pm 14{,}34$ for total learning score, $M = 12.60 \pm 1.66$ for delayed recall score and $M = 14.95 \pm .23$ for total delayed memory score), (Tanör, 2011). The mean BADL score was 15.79 ± 2.21 and the mean IADL score was 18 ± 2.94 which fall within the normal range. The mean MMSE score was 24 ± 1.64 indicating an early state cognitive impairment.

Pearson correlation analyses were conducted to determine the strength of association between SBST scores, ADL scores and FBM performance. As expected, a significant correlation was found between BADL and IADL ($r = .65$ $p < .01$). In addition, IADL score was found to be significantly correlated with SBST maximum short term learning score ($r = .488$, $p < .01$), SBST total learning score ($r = .483$, $p < .01$) and FBM total consistency (r

= .437, p < .05). On the other hand, there was no significant correlation of FBM consistency with SBST maximum learning score (r= .201, p > .05), SBST total learning score (r = .127, p = > .05) and SBST delayed total memory score (r = .220, p = > .05). Correlation findings between Flashbulb Memory total consistency and other variables are presented in Table 1.

Table 1. Correlation findings between Flashbulb Memory total consistency and other test scores

	BADL	IADL	SBST total learning score	SBST maximum short term learning score	SBST delayed total memory score
FBM total onsistency	.254 > .05	.437* < .05	.127 > .05	.201 > .05	.220 > .05

FBM: Flasbulb Memory, BADL: Basic Activities of Daily Life, IADL: Instrumental Activities of Daily Life, SBST: Sözel Bellek Süreçleri Testi (Verbal Memory Processes Test)

When AD group was divided into 2 in terms of FBM consistency as the more consistent and less consistent group based on the median score of FBM consistency, it was found that they only differed in IADL scale (t(1,27)= -1.945, p < .05). Although IADL scores of all patients were within normal range; the less consistent group had lower IADL scores (M = 17.19 ± 2.16) as compared to the more consistent group (M = 19.00 ± 1.95).

Finally, FBM performance for the first assessment and the consistency in second assessment of AD group were compared to the young controls. The results demonstrated that there was no significant difference between FBM performance of AD group (M= 3.72 ± .92) and healthy controls (4.00 ± .00) in the first assessment (t(45) = - 1.264, p = > .05). Finally and most importantly, AD group's FBM consistency measured 6 months later of the event (M = 2.76 ± 1.24) was not significantly different from the control group's FBM consistency (M = 2.50 ± 1.24), (t(45) = .692, p = > .05). In the first assessment of FBM and the second assessment 6 month later, patients' self-confidence about their answers (9.69 ± .76 and 8.83 ± 2.23 respectively) was quite high and was not found to be statistically different from healthy controls' self confidence levels (9.83 ± .38 and 8.44 ± 1.33; respectively), (t(45) = - .743, p = > .05, t(45) = .656, p = > .05; respectively). Comparison findings are presented in Table 2.

Table 2. Group comparison results for flashbulb memory test

AD Group		Young Control Group	
	Mean±SD	Mean±SD	p
FBM performance	3.72 ± .92	4.00 ± .00	> .05
FBM consistency	2.76 ± 1.24	2.50 ± 1.24	>.05
FBM self-confidence(1.)	9.69 ± .76	9.83 ± .38	>.05
FBM self-confidence(2.)	8.83 ± 2.23	8.44 ± 1.33	>.05

FBM: Flashbulb Memory, AD: Alzheimer's Disease

4. Discussion

The present study investigated flashbulb memories in Alzheimer's Disease and aimed to show they are relatively preserved in AD as compared to general memory loss. As expected, the most robust finding of the study was the preserved FBM scores in AD group while they had a noticable deficit in verbal memory encoding. Supporting evidence came from the control group comparison and revealed that FBM consistency of AD group was as high as the young control group. Parallel to our findings, literature suggests that the ability of recalling FBMs is preserved in old age as well (Davidson et al., 2002; Davidson et al., 2006). The results suggest a dissociation between FBMs and ordinary episodic memories in AD. Providing evidence for such a dissociation between emotional and non-emotional memory consolidation is not only important for literature but also for wellbeing of elderly with dementia. Since patients with dementia maintain the ability to encode emotional memories, caregivers should take the possible effects of traumatic events into consideration and treat patients accordingly.

On the other hand, the biological correlates of such a dissociation is not certain and should further be investigated. Although studies investigating FBMs in dementia are rare in literature, there are a lot of studies providing evidence for the relationship between emotional memories and amygdala (Spanhel et al., 2018). Given that flashbulb memories have a significant emotional component, it is reasonable to associate FBM with studies investigating emotional memories. Evidence shows that damage to the amygdala negatively affects emotional memory consolidation. In a study conducted with AD patients, for instance, it has been found that impairment in emotional memory recall of patients was highly related to the intensity of amygdalar damage regardless of generalized brain atrophy and cognitive impairments (Mori et al., 1999). Kazui et al. (2000) further investigated the impact of emotional arousal on declarative memory in patient with AD and healthy controls. Findings of the study showed that emotional arousal enhanced the memory retention in both groups.

The second major finding of this study was about the relationship between IADL scores and memory performance. Namely, patients' IADL scores were positively correlated with SBST performance and FBM consistency. Instrumental activities of daily living are considered to be complex behaviors requiring autonomy, quick decision making and organizational abilities, which clearly demonstrate the relationship between IADL functioning and executive functions. Indeed, in a plenty of studies instrumental activities of daily living were identified as screening procedures in dementia and IADL dysfunctions were found to be associated with cognitive impairment in both healthy and pathological aging populations (Barberger-Gateau et al., 1992, Grigsby et al., 1998, Kiosses et al., 2000, Royall et al., 2004). In a large scale study conducted with community-dwelling elderly, executive functions were identified as the best predictors of IADLs, as compared to the other cognitive abilities as memory, language or visuospatial abilities (Cahn-Weiner et al., 2000). In addition to its relationship with executive functions, a number of studies provided evidence for an asso-

ciation between functional activities and memory (McCue et al. 1990; Richardson et al. 1995; Farias et al. 2004). Deterioration of instrumental activities of daily living has been shown in patients with mild cognitive impairment; and decline in IADL performance was reported as a correlate of memory dysfunctions in AD (Matsuda and Saito 2005). According to our findings, instrumental daily activities seem to be associated with ordinary explicit memory consolidation as well as flashbulb memory retrieval.

The current study has several limitations as well. Firstly, the sample size was small. However, it is common and fair to employ small samples in studies with patients due to practical and ethical reasons. Secondly, we did not include an age-matched control group for AD patients, though we did not consider this as a major flow. On the contrary, it corroborated our hypothesis since AD group's performance was similar to the young controls.

In conclusion, the findings of this study suggest that flashbulb memory consolidation is preserved in early stage of Alzheimer's Disease, although everyday memory consolidation is impaired. To our knowledge, it was the first study showing a dissociation between flashbulb memories and other autobiographical memories in AD. However, it is still hard to be certain about the generalizability of our findings to other dementia populations. Particularly, we tested a population residing in a nursing home. These patients have more chance to interact socially as compared to home-residing patients. Future studies imaging studies focusing on neural networks of FBMs are also needed to elucidate the neural underpinnings of episodic-emotional memory dissociation in AD.

Patient informed consent: There is no need for patient informed consent.

Ethics committee approval: The ethics committee approval has been obtained from Uskudar University Non-Interventional Research Ethics Committee, report number of B.08.6.yök.2.üs.0.05.0.06/2017/76 (08 May 2017).

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Author contribution subject and rate:

Merve Çebi (%40): Analysed the data and wrote the whole manuscript.

Barış Metin (%20): Organised the research and supervised all processes

Burak Çevre (%30): Collected the data

Nevzat Tarhan (%10): Contributed to the manuscript with his comments and critiques.

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