The Influence of Age of Acquisition on Recall and Recognition in Alzheimer's Patients and Healthy Ageing Controls in Turkish

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Abstract

The current study set out to examine the influence of AoA on word recall and recognition tasks in 30 Alzheimer's patients and 28 healthy ageing control group. Each participant was presented with 20 words from Raman, Raman and Mertan (2014) norms that critically varied on AoA. A subtest of WAIS-R (Weschler, 1981; adapted into Turkish, Yılmaz, 2000) was employed to establish the vocabulary capacity of participants together with the Mini-Mental State Examination (Folstein, Folstein, and McHugh, 1975). The pattern of results showed that healthy ageing adults outperformed Alzheimer's patients in recall and recognition tasks and that overall early acquired words had an advantage over late acquired words. The results have implications for developing assessment tools and are discussed within the current theories of age of acquisition and the impact of the neurodegenerative loss of memory in Alzheimer's disease on lexicosemantic processing.

Introduction

Persistent difficulty in finding the right word in everyday conversations, recalling names of people and objects is often taken as a warning of dementia, especially regarding the early onset of Alzheimer's disease. Episodic memory is thought to be at the epicentre of this decline. The attribution of deteriorating word memory to episodic memory can be explained by the weakening of lexicosemantic networks (Altmann and McClung, 2008; Chertkow and Bub, 1990; Hodges and Patterson, 1995; Hodges, Patterson, Graham and Dawson, 1996). Behaviourally, episodic memory has been recognised to be the primary cognitive domain irreversibly changed in Alzheimer's disease (e.g., Albert, Moss, Tanzi and Jones, 2001; Bondi, Salmon, Galasko, Thomas and Thal, 1999). Although problems in episodic memory and/or difficulty in word retrieval are taken as an early sign of Alzheimer's disease, there are nevertheless problems in semantic memory in Alzheimer's disease too (Adlam, Bozeat, Arnold, Watson and Hodges, 2006). Insofar as words are considered, processing them has been demonstrated to be attuned to a number of psycholinguistic properties of words such as Age of Acquisition (AoA), imageability and frequency in Alzheimer's patients as in non-Alzheimer's groups. Simply put, even under compromised conditions, some words remain accessible and resilient to decline because of the unique fashion they are stored in long term memory. In the later stages of the disease, loss of comprehension of encyclopaedic facts, word meaning, public figures and events, personal facts and autobiographical episodes is reported which can have a profound consequence on everyday life (e.g., Greene, Hodges and Baddeley, 1995; Hodges and Patterson, 1995).

A singular and most prominent feature of human language is its continuity of development across the lifespan, although the rate of acquisition is highly variable and dependent on many internal and external factors and susceptible to changes over time.

In this respect, Age of Acquisition (AoA) is considered to reflect the growth of a language repository from a chronological dimension (Carroll and White, 1973). The dominant view is that words acquired earlier in life have a reliable advantage over words that are acquired later on in life (see Johnston and Barry, 2006 and Juhasz, 2005, for comprehensive reviews). Early acquired items have been reported to have an advantage in tasks such as picture naming, word naming, speeded word naming, word pronunciation durations, lexical decision, eye fixation times, face recognition, and episodic memory tasks (see Juhasz, 2005). Also, early acquired concepts are assumed to influence the concepts that are learned later in life (Brysbaert, Van Wijnendaele, and De Deyne, 2000; Steyvers and Tenenbaum, 2005), such that words that are learned earlier in life have a more extensive set of semantic connections than later acquired words (Steyvers and Tenenbaum, 2005). This premise is rooted in the way semantic networks are thought to come about in the classical work of Collins and Quillian (1969). Furthermore, theories of visual word processing assume three different types of representation in long term memory for each word: phonological, orthographic and semantic (e.g., Coltheart, 1978; Coltheart, Curtis, Atkins and Haller, 1993; Rastle and Coltheart, 1999). In turn, each word is assumed to be associated with other conceptually related words creating semantic networks (e.g., Collins and Quillian, 1969).

Reports from across different languages appear to have converging evidence, especially where AoA and Alzheimer's disease are concerned. For example, in Spanish Ferreiro, Davies, Nosti, Barbon and Cuetos (2009) showed the effect of AoA with healthy ageing adults and Alzheimer's patients who were instructed to name pictures of objects and pictures of actions in a naming task. As expected, more errors were made by the Alzheimer's patient group than the healthy ageing adults. On the other hand, action pictures had more error than the objects for both of the groups. Moreover, word naming of patients

was affected by word frequency, AoA, and name agreement. They showed the effect of impairment of the semantic system that related to Alzheimer's disease on the naming task. Activation of early acquired concepts had a quicker response and higher accuracy than for later acquired concepts (Ferreiro et al., 2009). In a further study, Cuetos, Herrera and Ellis (2010) compared Alzheimer's patients and healthy adults on a word recognition task in Spanish using words controlled for AoA and nonwords. Participants were required to undertake a lexical selection task where they were asked to point or name the real words on the sheet containing one word and three nonwords. The results of the study demonstrated that patients recognised early acquired words better than late acquired words. More errors were observed in patients than in healthy older adults as well as for late than early acquired words. In another study in Spanish, Cuetos et al (2012) developed AoA norms for 500 words with data from participants over the age of 60. The results from healthy ageing adults showed that they recognised and generated low frequency and late acquired words relatively more quickly than Alzheimer's patients. It was reported that AoA ratings of older participants were a better predictor of the performance for Alzheimer's patients than the ratings of young adults.

In English, Forbes-McKay et al. (2005) used a semantic fluency task requiring participants to generate exemplars for animal and fruit categories. Alzheimer's patients produced shorter, early acquired, higher frequency words, whereas healthy older adults produced more complex, longer, late acquired and low-frequency words. Also, word production was lower in Alzheimer's patients. Similarly, Sailor, Zimmerman and Sanders (2011) compared healthy older adults and Alzheimer's patients on a semantic and letter fluency task. The semantic categories included animals, fruits and vegetables. The letter categories included the words that begin with F, A and S. Participants were instructed to generate exemplars of a given category (animal, fruit or vegetables) or letters (F, A and S)

as fast as possible. The control group recalled and produced more items than Alzheimer's patients. The results showed that the words produced by Alzheimer's patients were early acquired and high-frequency words. The healthy ageing healthy adults recalled more items overall. The authors concluded that AoA influences verbal production independent of word frequency and that AoA has a semantic locus.

In an object recognition task, Holmes, Fitch and Ellis (2006) assessed the recognition performance of Alzheimer's patients and healthy ageing older adults using early and late acquired object pictures in their study. Objects and non-real objects were presented to participants, and they were required to judge whether an object was real or not and to name the object if it was real. If they failed to make the judgment, the initial phoneme of the word was given as a cue. If they still failed, the name of the target stimulus was provided. The results showed that Alzheimer's patients were more impaired in object naming. Overall, the patient group named earlier acquired objects better than those acquired later.

Healthy ageing is also associated with some changes in memory function. While there are losses in explicit memory which require intentional retrieval of information, such as in episodic memory tasks, there are fewer losses in semantic memory involved in the retrieval of facts and implicit memory, i.e., unintentional retrieval of experiences (e.g., Balota, Dolan, and Duchek, 2000). While age-related performance decreases in working memory tasks that involve the recall of information, a performance increase is observed in vocabulary tests (Park, Lautenschlager, Hedden, Davidson, Smith, and Smith, 2002). Neural changes indicate a functional (e.g., Gutchess, Welsh, Hedden, Bangert, Minear, Liu and Park., 2005; Moscovitch and Winocur, 1995) and a volumetric (Raz, Gunning-Dixon, Head, Rodrigue, Williamson and Acker, 2004) loss in the hippocampus. In this respect,

episodic memory is reported to be affected by cerebral ageing (Kinugawa et al. 2013), and more so than other types of memory (Levine et al. 2002).

The past 30 years have been marked by the rapid growth of studies focused on understanding the role of AoA on lexicosemantic processes in intact and impaired samples. Rochford and Williams (1962) were the first to report AoA effect in English in the naming performance of aphasic patients. AoA effect has since been established as a robust psycholinguistic variable which is found in every language that it has been tested in such as Dutch (Brysbaert, Lange, and Wijnendaele, 2000); Spanish (Sanfeliù and Fernandez, 1996); French (Alario and Ferrand, 1999; Bonin, Chalard, Méot and Fayol, 2002); Turkish (Raman, 2006, 2011) and Italian (Wilson, Ellis and Burani, 2012) leading to the suggestion that AoA effects are 'universal' (Raman, 2006).

Several theoretical accounts have been offered to explain the AoA phenomenon, one of which is the arbitrary mapping hypothesis by Ellis and Lambon-Ralph (2000). Stronger AoA effects are attributed to irregular and/or inconsistent, unpredictable or arbitrary mappings between two representations (such as orthography to phonology - OP) during the learning process. In other words, the AoA effect is predicted to be minimal or disappear under regular, consistent and nonarbitrary OP conditions. Although this theoretical account can explain the AoA effect in English which presents an orthography with mixed OP mapping at best, it fails to explain the reliable AoA effects reported in languages with consistent/regular OP mappings such as Turkish.

Another account for AoA effect is the semantic hypothesis proposed by Brysbaert et al (2000) which predicts that the size of AoA effect will be higher in tasks that require lexicosemantic access because early items are assumed to enter the representational network first with later acquired words constructed on early items, i.e. stronger semantic networks for earlier items. The semantic hypothesis suggests a possible semantic

contribution to the emergence of AoA effects in psycholinguistic tasks (Brysbaert and colleagues). While the exact role of AoA on recall and recognition is still debated in typical populations across different languages (Dewhurst et al., 1998; Raman et al., 2018) because Alzheimer's presents a gradual loss of episodic as well as semantic memory, the extent to which AoA is involved in recall and recognition remains a crucial enquiry.

The relationship between AoA and memory, particularly episodic memory, is unique and a difficult one to disentangle. For example, Dewhurst, Hitch and Barry (1998) manipulated AoA and frequency in three different experiments in delayed word recognition and recall tasks. Frequency and AoA were manipulated in the first task. The findings of the first experiment showed an advantage in the recognition task of late acquired and low-frequency words. The second experiment differs from the first one because it does not manipulate frequency. Late acquired words were just matched on frequency, imagery and word length. Similar to the first experiment, a recognition task was given in the second experiment. Likewise, the findings of experiment 2 supported the advantage of late acquired words over early acquired words. Also, the second experiment showed that there were more false alarms for late acquired words than early acquired words. In the third experiment, participants took part in a recall task to assess their word retrieval. It was found that participants remembered high-frequency words better than low-frequency ones in the recall task. When frequency was controlled, performance was higher for late acquired words compared to the early acquired words (Dewhurst et al., 1998).

Most recently, similar to Dewhurst et al., (1998), the role of AoA and frequency on episodic memory were examined orthogonally in young adults in a free recall task in Turkish (Raman, Raman, İkier, Kilecioğlu, Uzun Eroğlu and Zeyveli, 2018). The findings were contradictory to those reported by Dewhurst et al (1998) in English: the main

difference was that both AoA and word frequency had a significant main effect on free recall in Turkish whereas late acquired words were recalled better in English but only when frequency was controlled. A similar result to Turkish was also reported for bilingual Russian-English speakers where a main effect for AoA was reported for both monolingual and bilingual participants (Volkovyskaya, Raman and Baluch, 2017).

Although Turkish has an extremely transparent alphabetic writing system (Raman, 2006; 2011), it is clear from the emerging literature that the organisation of lexicosemantic networks has commonalities with less transparent writing systems. In this respect, evidence for a reliable word frequency effect was first reported as early as 1996 by Raman, Baluch and Sneddon as well as a word imageability effect (Raman and Baluch, 2001). Moreover, neuropsychological reports of BRB, a bilingual Turkish-English case study, demonstrate the extent to which word processing in impaired language processing is influenced by psycholinguistic variables (Raman and Weekes, 2005a; 2005b; Weekes and Raman, 2008). The extant body of AoA research in Turkish includes reports of AoA effects in visual word recognition in naming tasks (Raman, 2006); and in visual word recognition and picture naming in adult developmental dyslexics (Raman, 2011). Turkish nevertheless remains an understudied language, and to the best knowledge of the authors, there are currently no previous reports on the role of AoA on Alzheimer's patients in Turkish. Recent research has focused on understanding the extent of the degradation of sentence production and comprehension in Turkish Alzheimer’s patients (Can, Kuruoğlu, Yener, and Özsoy, 2017; Can and Kuruoğlu, 2018).

The rationale is based on establishing which characteristics of words in Turkish remain resilient to neuronal degeneration and accessible in neurodegenerative disease such as Alzheimer’s in comparison to healthy ageing adults. In this respect, the present study is the first to compare the two groups in Turkish on recall and recognition in a

factorial design. The study also aims to compare the vocabulary performance of healthy older adults and Alzheimer's patients, based on the suggestion that Alzheimer's patients' vocabulary capacity stays the same and that problems in memory are the root of the sentence production and comprehension difficulties in Turkish (Can and Karakaş, 2005).

Method

Design

The study employed a 2x2 mixed factorial design with Ageing Group (healthy ageing, Alzheimer's) as a between-participants, and AoA (early, late) as within-participants variables. The correct scores on the free recall and recognition tasks formed the DV.

Participants

All the participants were native Turkish speakers resident in Istanbul, Turkey and took part in the study on a voluntary basis. Initially, 30 Alzheimer's patients (13 females and 17 males) with a mean age of 76.53 years (range 61-89) (SD= 7.48) and 32 healthy ageing adults (19 females and 13 males) aged between 54 and 88 years with a mean age of 70.84 years (*SD* = 8.42) were recruited for the study. However, preliminary analyses showed that the age difference between the two groups was statistically significant [$t(60)=2.8$ $p<0.01$] given that four participants below the age of 60 were in the control group. When these four cases were removed, the control group consisted of 17 females and 11 males with a mean age of 72.89 (SD=6.78) rendering the difference between the two groups nonsignificant [$t(56)=1.9$ $p=0.06$]. Moreover, when the MMSE scores were reanalysed, the findings showed a difference between the initial mean score (N=32) versus the final sample (N= 28) of healthy ageing adults, 25.88 (SD=2.28) and 25.75 (SD=2.22), respectively. This difference reached statistical significance [$t(56)=4.41$ $p<0.0001$]. Coupled with the

findings reported for age, it was deemed rational to retain only the sample of 28 healthy ageing adults for the purpose of the study (see Table 1 for details).

Alzheimer's patients were recruited from Istanbul University Çapa Medical School, Alzheimer's Disease and Dementia Clinique and Neurology Department at Maltepe University Hospital. They were all early-stage Alzheimer's disease patients who provided oral and written consent themselves. The patients' diagnosis was based on their previous medical history, and neuropsychological evaluations by neurologists and neuropsychologists by the administration of a broad cognitive skill battery including Weschler Memory Scale, Addenbrooke's Cognitive Examination, Geriatric Depression Scale, Clinical Dementia Rating (CDR), Short Portable Mental Status Questionnaire (SPMSQ), The Blessed Orientation Memory Concentration (BOMC) Test, Blessed Dementia Scale are the excessive criteria in Çapa Medical School Hospital. Similarly, Maltepe University Hospital used the neuropsychological evaluation battery as the evaluation criteria in the diagnosis of Alzheimer's disease.

Healthy ageing participants with no history of memory and/or mild cognitive impairments and living in their own homes were recruited as controls. Formal analysis of data showed that years in education was similar for both groups with a mean of 13.9 years (SD=6.8) for healthy ageing controls and 12.9 years (SD=7.1) for Alzheimer's patients. This difference was statistically nonsignificant [$t(56)=.54$ $p>0.05$].

MMSE scores between the two groups demonstrated a higher mean score for the healthy ageing control group compared to Alzhemier's patients, 25.75 (SD=2.22) and 22.40 (SD=3.4) respectively. This difference was statistically significant, $t(56)=4.41$ $p<0.0001$. As a further measure, Alzheimer's patients' MMSE scores from the study were analysed with the MMSE scores from their prior hospital records in order to identify and

eliminate outliers and/or rapid decline. It was found that the two MMSE scores were significantly correlated with each other ($p<0.01$).

Table 1: Summary descriptive statistics with mean scores and SD in brackets for Alzheimer's Patients and Healthy Ageing Control Group

	Alzheimer's Patients			Healthy Ageing Control Group		
	Male (N=13)	Female (N=17)	Overall (N=30)	Male (N=11)	Female (N=17)	Overall (N=28)
Age	77.27 (7.69)	75.54 (7.37)	76.53 (7.48)	76.37 (8.52)	70.65 (4.30)	72.89 (6.78)
Education in years	15.65 (7.08)	9.23 (5.45)	12.9 (7.1)	12.36 (6.12)	14.02 (7.28)	13.9 (6.8)
MMSE	23.47 (2.89)	21.0 (3.6)	22.4 (3.4)	26.27 (1.19)	25.41 (2.67)	25.75 (2.22)
WAIS-R	59.76 (9.67)	58.0 (7.59)	59.0 (8.73)	65.0 (6.57)	66.41 (5.47)	65.86 (5.85)

Materials

Experimental materials consisted of 20 words obtained from the Turkish colour picture norms developed by Raman, Raman and Mertan (2014) from the original Snodgrass and Vanderwart (1981) picture norms. The words were carefully selected to represent early and late acquisition with 10 from each category. Given the strong link between AoA and frequency, attention was paid to match early and late stimuli on frequency. A blank page was provided to participants in the recall phase to write down the words that they

remembered. In the recognition task, an additional eight new words were used as foils, and the stimuli consisted of a total of 28 words. The stimuli can be seen together with English translations in the Appendix.

In addition, the Vocabulary Subscale of WAIS-R (Weschler, 1981) adapted and standardized into Turkish by Yılmaz (2000), and the MMSE (Folstein et al, 1975) were used to establish a profile for each of the participants. Finally, a demographic questionnaire was used to gather information about age, gender and general health.

Procedure

The study commenced after ethical approval was sought and granted at Yeditepe University, Istanbul and participating hospitals. Participation was voluntary, and participants were required to give informed consent by reading and signing the informed consent form. Alzheimer's patients were tested individually in a quiet and well-lit room in the Neurology Department, at Çapa Medical School Hospital and in the Neurology Department, at Maltepe University Hospital, Istanbul. Healthy ageing adults were tested individually in their homes in a quiet setting. All the participants completed the tasks in a single session that took approximately 45-60 minutes.

The experimental stimuli in the study phase of the recall task were presented by using a PowerPoint presentation. Each of the 20 items appeared on the screen in 48 lowercase font for 2000 ms, with an interstimulus interval of 2000 ms. The order of presentation was randomised for each participant who was asked to focus on the screen while the words were presented one at a time. An immediate recall task followed the study phase and participants were instructed to recall as many of the words they had just seen by writing them down. Each participant had a short break once this task was completed. In the subsequent yes/no recognition task, participants were represented with the initial stimuli list and an additional eight new words as foils. Four of the foils were early acquired, and

the other four late acquired words (see Appendix). The participants were instructed to simply respond with a yes if they thought they had seen the word before or with a no if they had not. The order of presentation was again randomised for each participant. The responses were recorded as correct if the item was in the initial list, incorrect if it was not and as a false positive if the participant said yes to a foil.

Each participant was required to undertake a vocabulary test to define the meaning of the experimental stimuli. Additionally, participants were presented with the vocabulary subscale of WAIS-R (Yılmaz, 2000). This test included 35 words ranging from easy to difficult, and the participants were asked to define these words. Finally, participants were administered the MMSE (Folstein et al, 1975) and the background questionnaire. All participants were fully debriefed about the details of the study.

Results

Recall Task

Data were subjected to descriptive and inferential statistics, as reported below.

Table 2: Mean recall scores with SD for early and late acquired words for Healthy Ageing and Alzheimer's patients

	Healthy Ageing (N=28)	Alzheimer's (N=30)
Early words	4.79 (1.81)	2.53 (2.25)
Late words	3.92 (1.67)	1.70 (1.17)

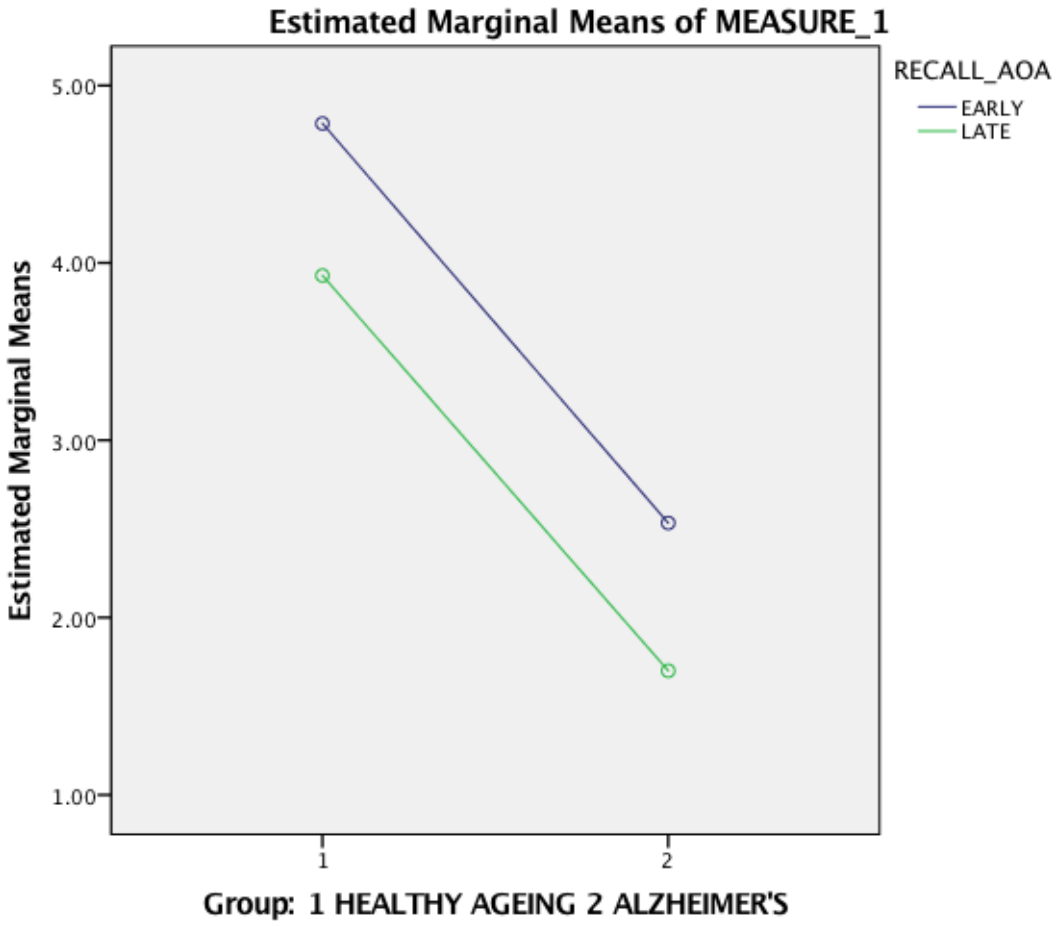

Figure 1: Line Graph depicting mean recall scores for early and versus words in healthy ageing group and Alzheimer's patients

As can be seen in Table 2, healthy ageing adults outperformed Alzheimer's patients on the recall of words under both early and late acquired conditions. Data were subjected to a 2 (AoA: Early, Late) by 2 (Group: Alzheimer's patients, healthy ageing) factorial ANOVA which showed a significant main effect for AoA [$F(1,56)=7.69$ $p<0.005$] and a significant main effect for participant groups [$F(1,56)=40.40$ $p<0.0001$]. The interaction did not reach significance [$F(1,56)=0.002$ $p=0.96$] (see Fig 1).

Intrusions from non-studied items were low for both groups with a mean value of 0.93, (SD = 2.02) for healthy ageing controls and 1.93 (SD = 1.87) for Alzheimer's patients. This difference was marginally significant [$t(56)=1.97$ $p=0.054$].

One methodological concern was whether letter length would have an effect on recall as early acquired items were on average two letters shorter than late acquired words. This was addressed by employing a Oneway ANOVA on correct recall scores for items which showed a nonsignificant effect for letter length, $F(6,39)=1.52$ $p=0.20$. Letter length and participant group were simultaneously entered into a regression analysis for words which confirmed an overall significant equation [$F(2,37)=14.51$ $p<0.0001$ $R=0.66$] with participant group as a significant predictor variable ($\beta=0.62$, $t=5.06$, $p<0.0001$) but not letter length for correct recall scores ($\beta=-0.23$, $t=-1.85$, $p=0.072$).

Recognition Task

The results of the recognition task, as reported in Table 3, showed that both groups of participants recognised early and late words with similar accuracy. However, the healthy ageing group showed a better recognition of later acquired words while Alzheimer's patients were better at recognising early acquired words. Data were subjected to a 2 (AoA: Early, Late) by 2 (Group: Alzheimer's patients, healthy ageing) factorial ANOVA which showed a nonsignificant main effect for AoA [$F(1,56)=0.12$ $p=0.7$] but no interaction between the variables [$F(1,56)=1.30$ $p=0.3$] with a significant main effect for group [$F(1,56)=4.23$ $p<0.04$]. As can be seen in Fig 2, there is a trend for a possible interaction.

Table 3: Mean recognition scores with SD for early and late acquired words for Healthy Ageing and Alzheimer's patients

	Healthy Ageing (N=28)	Alzheimer's (N=30)

Early words	7.54 (2.30)	6.77 (2.28)
Late words	7.75 (1.97)	7.03 (2.28)

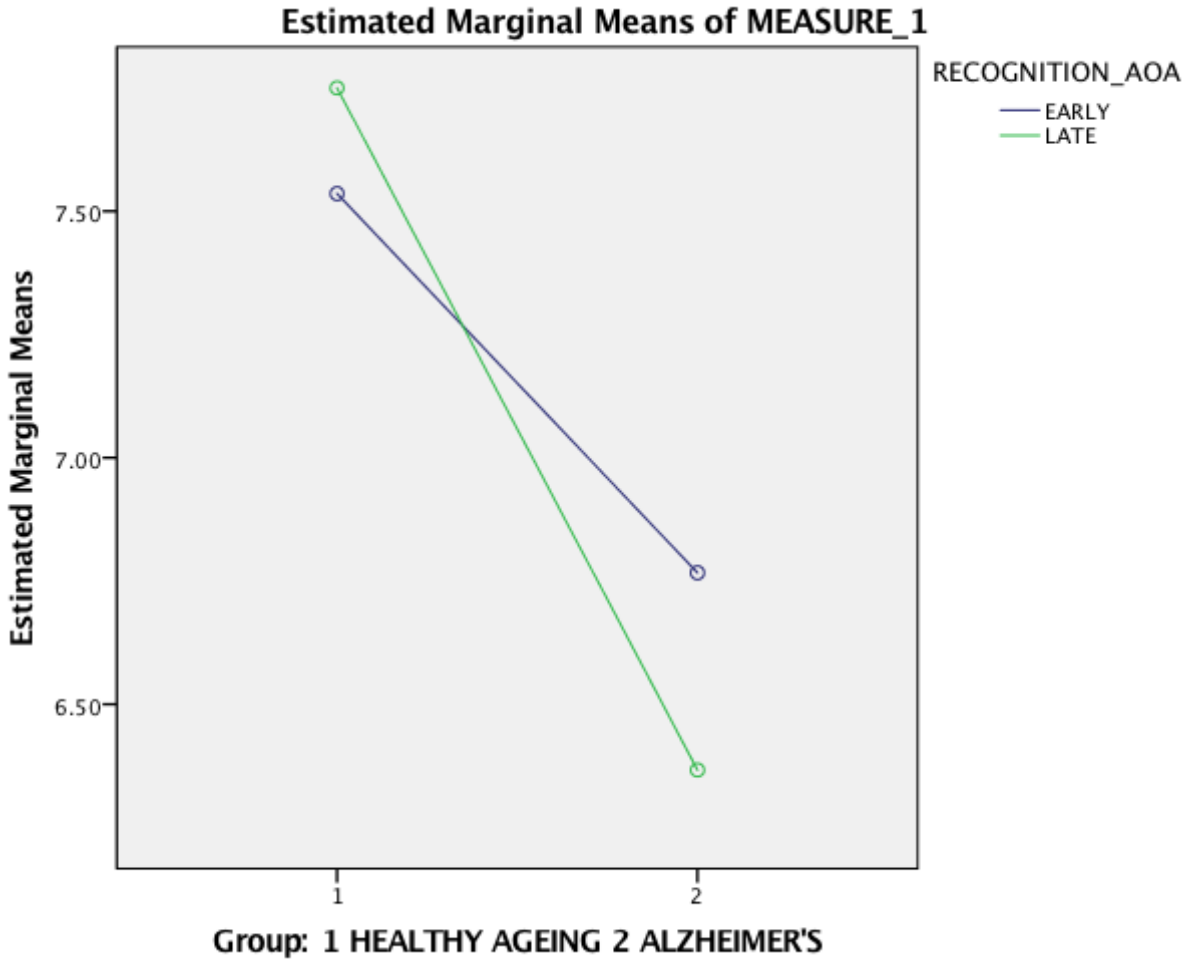

Figure 2: Line Graph depicting mean recognition scores for early and versus words in healthy ageing group and Alzheimer's patients

Alzheimer's patients mean false alarms score was three times larger than healthy ageing participants, 1.83 (SD=1.80) and 0.64 (SD=0.95) respectively. Although Levene's homogeneity test showed unequal variances between the two groups, and this difference reached statistical significance [$t(44)=3.75$ $p<0.003$]. The data on misses showed a similar trend with a mean score of 4.71 (SD=3.63) for Alzheimer's patients and 6.87 (SD=4.29) for healthy ageing adults. This difference was also significant [$t(56)=2.1$ $p<0.04$]

Vocabulary Test

Healthy ageing adults had higher vocabulary scores compared to Alzheimer's patients, on the vocabulary subscale of WAIS – R, 65.86 (SD=5.85) and 59.00 (SD=8.73) which was statistically significant, $t(56) = 3.49$, $p< 0.01$. On the vocabulary test for the critical test items, Alzheimer's patients scored 34.57 (3.74) compared to 37.29 (SD=3.90) by healthy ageing controls. This difference also reached significance, $t(56) = 2.71$, $p< 0.009$.

MMSE and participant group were entered into a linear regression analysis which showed a significant overall effect [$F(2.55)=11.0$ $p<0.0001$ $R=0.54$] and that MMSE scores were the best predictor of the vocabulary subscale of WAIS-R ($\beta=0.9$, $t=2.88$, $p<0.01$) but not participant group ($\beta=-3.72$, $t=-1.74$, $p=0.08$).

Case Study

The first author observed that one of the Alzheimer's patients who worked in the automobile industry for a long time, recalled words related to his profession well. For exploratory purposes, a new list of 20 items only made up of the terms used in the automobile industry (e.g., carburettor, crankcase, sensor) were created and the patient was re-invited for a recall and recognition test. The results showed that his overall recall was

similar to the healthy ageing group (35%), and his overall recognition was better than healthy ageing adults (80%). His definition of automobile industry items in the vocabulary test was almost perfect (36/40). He missed only two items (sensor, suspension) because they newly entered the language, and he claimed that he had never heard of these items. However, he showed very high false alarms (20%), indicating low discrimination accuracy in recognition.

Discussion

The study set out to examine whether performance on some words in Turkish were less prone to neurodegeneration in Alzheimer's patients compared to a healthy ageing control group by examining the role of AoA on word recall and recognition. Although reports of AoA effect exist in Turkish in word naming (Raman, 2006; 2011) and free recall (Raman et al., 2018), to the best knowledge of the authors, this is the first empirical research examining the impact of AoA on episodic memory, in recall and recognition, with an ageing Turkish sample which included both healthy ageing adults and Alzheimer's patients. The study also aimed to investigate vocabulary capacity in both groups.

In the recall task, it was found that healthy ageing adults performed significantly better in remembering words compared to Alzheimer's patients. This is in line with previous findings, especially in Spanish. For Alzheimer's patients, early acquired words were recalled best, indicating an advantage for early acquired items. These results are consistent with the results of Sailor et al (2011) and Forbes-McKay et al., (2005) which show better memory for items that are acquired the earliest in Alzheimer's disease. Our results are also consistent with the findings of Grober and Kawas (1997) who showed better recall in healthy ageing adults compared to Alzheimer's patients.

Moscovitch et al. (2006) showed that remote events (episodic and autobiographical memory) are hippocampus-dependent, an area impaired in Alzheimer's

disease. Westmacott et al. (2004) showed that this hippocampus-dependency reveals itself in the semantic memory impairment of Alzheimer's patients for recent events. Remote events were more resistant to the effect of Alzheimer's disease because they were no longer hippocampus-dependent, while the recent memories were more fragile (Westmacott, et al. 2004). The results of the current study are also consistent with these findings, indicating that early acquired words, which are remote memories that are no longer hippocampus-dependent.

The results of the recognition task again revealed an advantage for healthy ageing adults compared to Alzheimer's patients which approached significance. These results are consistent with the results of Cuetos et al., (2015), which show better recognition in healthy ageing adults, compared to Alzheimer's patients. Results of both recall and recognition tasks show that Alzheimer's patients are worse in memory performance compared to healthy ageing adults and are in line with those previously reported in the literature (Grober and Kawas, 1997; Tippett et al., 2007; Ober and Shenaut, 2014).

Alzheimer's patients were better at recognising late acquired words than early acquired words, revealing a reverse AoA effect. One reason for this effect may be the distinctiveness of late acquired items (Balota et al., 2002; Holmes et al., 2006; Cuetos et al., 2015). For the healthy ageing control group, both early acquired and late acquired items were recognised to the same extent.

This pattern of results is consistent with previous reports on recall for Alzheimer's patients (Grober and Kawas, 1997; Cuetos et al., 2015; Ober and Shenaut, 2014; Tippett et al., 2007; Holmes et al., 2006; Catling et al., 2013; Silveri et al., 2002; Druks, et. al., 2006; Hodgson and Ellis, 1998). Impairment in the preclinical period of Alzheimer's disease begins with the impairment in episodic memory which is sensitive to physiological changes, including ageing (Almond and Morrison, 2014; Chen et al, 2000).

In the present study, mixed lists were used in the experimental conditions in which words critically manipulated on AoA were presented randomly. The mixed type of word presentation eliminates the problem of primacy/recency effect bias that can affect the performance of participants. Future studies can investigate AoA and word frequency effects in recall and recognition, using pure lists, in which items of the same type are presented as blocks.

Overall, the vocabulary performances of both groups were quite good on the subtest of the Turkish version of the WAIS-R (Weschler, 1981; Yılmaz, 2000). However, healthy ageing adults outperformed Alzheimer's patients. The results of the regression analysis found that increased severity in Alzheimer's disease, as measured by MMSE, predicted poor WAIS-R performance. This finding contradicts the view that vocabulary capacity does not decline much in Alzheimer's disease (Can and Karakaş, 2005; Westmacott et al., 2004).

One account of differences in performance between the two groups reported here is cognitive reserve (Stern, 2012). By definition, cognitive reserve refers to those individual differences that are assumed to shield against Alzheimer's disease such as IQ, bilingualism, profession, educational levels, and enhanced lifestyles. The protective nature of such internal and external factors is attributed to the development of flexible strategies which continue to grow across the lifespan. Although, an attempt was made in the current study to control for as many variables between the two groups as possible, the role of cognitive reserve cannot be discredited. While individuals with enhanced cognitive reserve are not protected from developing Alzheimer's disease, they might be inherently better at developing coping mechanisms at the cognitive functional level in comparison to those with lesser cognitive reserve.

A Case Study: An Exploratory Investigation of Expertise on a Single Participant

As reported above, one of our observations was the outstanding performance of an Alzheimer's patient who worked in the automobile industry for a long time on words related to his profession. For exploratory purposes, a word list related to the automobile industry items was prepared. The participant was re-invited to take part in the study, namely in recall, recognition, and vocabulary tasks utilising expertise items only. His vocabulary for items of his expertise was almost perfect. He only missed two items, which entered the language late, a finding consistent with the findings of Westmacott et al. (2004). For the expertise items, his recall was similar to the healthy ageing group, and his recognition was better than the healthy ageing group; however, he had very high false alarm rates in recognition, indicating that he marked almost any item related to the automobile industry, as an old item. Thus, his discrimination accuracy in recognition was low. However, the results still imply that he is able to categorize these items semantically and that knowledge of expertise may be more resistant to the effects of Alzheimer's disease. Many studies are showing that expertise can override the effects of healthy ageing on memory (Herzmann and Curran, 2011). The extent to which expertise affects memory performance in Alzheimer's patients remains as an interesting area of future investigation.

Collectively, the findings from the study confirm that the progressive degradation of the lexicosemantic networks in Alzheimer's' disease leads to poor word recall and recognition in comparison to the healthy ageing control group in Turkish. We envisage that the development of a psycholinguistic assessment tool in Turkish would provide clinicians and practitioners with an invaluable and reliable neuropsychological instrument in the assessment of early onset of Alzheimer's and other types of dementia. The emergence of an AoA effect reflects the chronological architecture of episodic memory

development and given the robustness of degradation of AoA to Alzheimer's disease as reported here, it can be utilised as a screening tool towards the early identification of preclinical and/or prodromal Alzheimer's Disease. One implication of this study, regarding the early screening of Alzheimer's disease, is the potential of utilising AoA in recall and other psycholinguistic tasks as a supplementary clinical tool in establishing a developmental trajectory of the disease. Given the stability of vocabulary acquisition across the lifespan, AoA can be used in the maintenance as well as the screening of cognitive functioning together with other psycholinguistic factors such as word frequency and imageability. Ultimately, the current study offers a preliminary examination of impaired lexicosemantic processing in Alzheimer's disease under experimental conditions in comparison to carefully matched controls that will help establish a better understanding of the underpinning cognitive mechanisms in Turkish.

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Appendix A: Stimuli list

Early AoA			Late AoA		
Turkish	English	AoA	Turkish	English	AoA
göz	eye	1.48	anahtar	wrench	3.00
ay	moon	1.77	piyano	piano	3.15
el	hand	1.43	çekiç	hammer	3.03
güneş	sun	1.51	flüt	flute	3.10
ayak	foot	1.41	tilki	fox	2.59
ampül	light bulb	1.75	vida	screw	3.05
şapka	hat	2.1	gergedan	rhinoceros	3.21
dudak	lips	1.39	akordeon	accordion	3.23
sinek	fly	2.07	törpü	nail file	3.02
çorap	socks	1.79	kokarca	skunk	2.97
MEAN SD		1.65 0.23	MEAN SD		3.03 0.17

Foils used in the recognition task

Early AoA			Late AoA		
Turkish	English	AoA	Turkish	English	AoA
Balon	Balloon	1.38	Puro	Cigar	3.25
Ağaç	Tree	1.54	Kilise	Church	3.26
Ekmek	Bread	1.62	Keski	Chisel	3.31
Muz	Banana	1.62	Harp	Harp	3.95