Differential Effects of Age of Acquisition and Frequency on Memory: Evidence from Free Recall of Pictures and Words in Turkish

Ilhan Raman[1], Evren Raman[2], Simay İkier[3], Elçin Kilecioğlu[4], Dilek Uzun[4], & Şebnem Zeyveli[4]

[1] Middlesex University, London, UK; [2] Brunel University, London, UK; [3] Bahçeşehir University, Istanbul; [4] Yeditepe University, Istanbul, Turkey.

Key words: Age of acquisition; frequency; episodic memory; free recall; picture and word processing; Turkish

Address correspondence to Ilhan Raman, i.raman@mdx.ac.uk, Department of Psychology, Middlesex University, The Burroughs, Hendon, London, UK, NW4 4BT

Running head: AoA and Frequency in Free Recall

Abstract

The advantage of processing early acquired items over late acquired items in lexical and semantic tasks across a number of languages is well documented. Interestingly contradictory evidence has been reported in recall tasks where participants perform better overall on late acquired items compared to early acquired items in English (Dewhurst, Hitch & Barry, 1998). Moreover, free recall has also been reported to be modulated by frequency as well as list type in that studying pure lists of high frequency words or low frequency words typically leads to a recall advantage for high frequency words (Dewhurst, Brandt & Sharp, 2004). This recall advantage either disappears or is reversed when the same items are presented in mixed lists containing both high and low frequency items (Dewhurst et al, 2004). The current experiment aims to shed further light on this discrepancy by exploring the influence of AoA and frequency on free recall on standardised pictures and their names (words) in Turkish in mixed and pure lists (Raman, Raman & Mertan, 2014). Eighty participants were recruited from Yeditepe University and were assigned to either a picture (N=40) or a word condition (N=40) in which stimuli were presented in either a mixed or a pure list. Following a distracter task, participants were asked to recall as many pictures or words as they could remember from the list they viewed. The findings lend partial support to the previous findings in English and the implications are discussed within the context of current cognitive frameworks.

Introduction

A considerable amount of research has confirmed the role of Age of Acquisition (AoA) as an important psycholinguistic variable in lexical and semantic tasks including but not limited to picture naming, word naming and lexical decisions (see Johnston & Barry, 2006; Juhasz, 2005 for reviews). In this respect, the AoA effect refers to the phenomenon that items such as words and pictures acquired early in life are processed faster and more accurately than words and pictures acquired later in life. Although the AoA effect was originally reported in English (e.g., Carroll and White, 1973; Morrison & Ellis, 1995), it has since been reported in many languages such as Dutch (Brysbaert, Lange, & Wijnendaele, 2000); Spanish (Sanfeliù & Fernandez, 1996; Wilson, Cuetos, Davies, & Burani, 2013); French (Alario & Ferrand, 1999; Bonin, Chalard, Méot, & Fayol, 2002); Turkish (Raman, 2006, 2011); Italian (Wilson, Ellis, & Burani, 2012); Chinese (Weekes, Shu, Hao, Liu, & Tan, 2007); Russian (Tsaparina, Bonin, & Méot, 2011; Volkovyskaya, Raman, & Baluch, in press) and Persian (Bakhtiar, Nilipour, & Weekes, 2013).

Thus far the AoA effect has received unprecedented attention in lexical and semantic tasks that led to the development of different theoretical frameworks in an attempt to provide an explanation for its emergence. These range from attributing the AoA effect solely either to phonological representations, as in Brown and Watson's (1987) phonological completeness hypothesis, or to semantics as in Brysbaert and colleagues' (2000) semantic locus hypothesis (also see Steyvers & Tenenbaum, 2005) to Ellis and Lambon Ralph's (2000) network plasticity hypothesis proposing a multiple-loci view that involve orthographic, phonological and semantic representations. One critique of the AoA is its very close association with frequency in that most early acquired items also tend to be encountered frequently in life and vice versa, hence leading to the proposition of the cumulative-frequency hypothesis as an explanation for the additive effects of AoA and frequency (see Zevin & Seidenberg, 2002). In this respect, Ellis and Lambon Ralph (2000) argued that although the origin of AoA and frequency may be reduced to a common learning mechanism in their

simulations, their additive effects could not nevertheless be reduced to a cumulative-frequency function. It has since been demonstrated that AoA and frequency can yield orthogonal effects in studies that use carefully selected materials (e.g. Cortese & Khanna, 2008; Ghyselinck, Custers & Brysbaert, 2004; Menenti & Burani, 2007).

Theoretically it has been challenging to provide a comprehensive account of AoA partly because of its close relationship to frequency (see Juhasz, 2005 for a review). Brysbaert and colleagues' (2000) semantic hypothesis provides an explanation for the advantage of processing speed and accuracy of early versus late acquired items in tasks that involves semantic activation. As early acquired items are assumed to enter and become more established in a given semantic network first, items that enter the same network afterwards are late acquired with weaker semantic networks.

A review of the extant literature on the effects of AoA on memory tasks, however, show a different and a contradictory account to the outcome of the AoA effect in lexical and semantic tasks. The first experimental study to examine whether AoA influences recall was reported in English by Morris (1981) who found a significant AoA effect in recall in mixed word lists with an advantage for later acquired words compared to early acquired words. Subsequently, the study was replicated by Coltheart and Winograd (1986) who used pure word lists instead and reported no AoA effects. More recently, Cortese et al (2010; 2015) found an advantage for late acquired stimuli over early acquired stimuli, namely, monosyllabic and disyllabic English words in mixed lists, in recognition tasks, i.e. declarative memory. In English, the advantage for late acquired items has often been credited to a semantic distinctiveness advantage observed in recognition memory.

The influence of context or the nature of items in a list in lexical processing especially on RTs is well documented in English (e.g. Frederiksen & Kroll, 1976; Lupker, Brown & Colombo, 1997) as well as Turkish (Raman, Baluch & Besner, 2004). The rationale for presenting stimuli in pure versus mixed lists is that any processing disparity between different categories of stimuli is accentuated in pure lists thus producing a larger effect. Put simply, a mixed list typically consists of

two different types of the critical variable under investigation such as frequency (high/low), AoA (early/late), word/nonword whereas a pure list will only consist of just one type of stimuli of the critical variable such as either high frequency or low frequency; either early or late AoA; either words or nonwords. The impact of list type has also been demonstrated in word recall tasks with high and low frequency words where the emergence of a frequency effect is dependent on whether word stimuli are presented in pure or mixed lists (Gillund & Shiffrin, 1984; Gregg, Montgomery, & Castano, 1980). Conversely, recall of high frequency words have been reported to have an advantage over low frequency words in pure lists (DeLosh & McDaniel, 1996) whereas this effect is either reversed or nullified when high and low frequency words are presented in mixed lists (DeLosh & McDaniel, 1996; Dewhurst et al, 2004; MacLeod & Kampe, 1996).

The methodological shortcomings of Morris (1981) and Coltheart and Winograd (1986) studies were overcome in the Dewhurst et al's (1998) Experiment 3 which took the implications of such methodological manipulations on recall into consideration by combining both mixed and pure lists of stimuli while AoA and frequency were factorially controlled. An advantage for low frequency and late acquired words in recall was reported under the mixed list condition. In the pure list condition, Dewhurst et al (1998) reported only a significant frequency effect which was reversed, that is, participants were better at recalling high frequency words compared to low frequency words. No reliable effect was found for AoA in the pure list condition. There was also no interaction between the two variables leading to the conclusion that 'Findings were attributed to the more distinctive encoding of low-frequency and late-acquired words'(p284). In summary, the Dewhurst et al AoA results showed a similarity to the pattern of results previously reported for word frequency effect; that is, AoA effect is also modulated by the characteristics of the items in a list and that it has a role in episodic memory. This is not surprising when one considers that AoA and frequency are assumed to originate from a common learning mechanism (e.g. Ellis and Lambon Ralph, 2000).

Turkish presents an interesting and an extremely regular orthographic medium for all word stimuli due to its distinct and straightforward, transparent relationship between orthography and phonology. In this respect, lexical and semantic processing in Turkish is devoid of confounding variables such as orthographic irregularity that are reported to affect such processes in less transparent and opaque orthographies (Raman, Baluch & Sneddon, 1996; Raman & Baluch, 2001; Raman et al, 2004). For instance, lexical and semantic processing in English have been demonstrated to be affected by its irregular orthography (Hino & Lupker, 2000; Strain, Patterson & Seidenberg, 1995; Van Orden, Pennington, & Stone, 1990). Insofar as its very regular orthography is concerned, past research has found a reliable frequency effect (Raman et al, 1996), list effect (Raman et al, 2004) and AoA effect in word and in picture naming (Raman, 2006; 2011) in Turkish.

To date, Dewhurst et al (1998) Experiment 3 remains as the leading source of reference for the impact of AoA and Frequency on recall in English in pure and mixed lists. The purpose of the current study is to extend Dewhurst and colleagues' research to address concerns related to identifying underlying mechanisms in free recall, including episodic encoding and to explore i) if and ii) the extent to which memory for words is shaped by orthographic transparency by employing the characteristics of Turkish. To the best of the authors' knowledge, this is the first study which examines the role of AoA on free recall in a language besides English. Both AoA and frequency are inherent components of the lexical architecture and although intertwined they can nevertheless be orthogonally pitted against each other to examine the mechanisms involved in free recall and episodic encoding. Our line of thought however, is that it is counterintuitive for late acquired, low frequency words to have an advantage in a free recall task given these items have a shorter residency in episodic memory compared to early acquired, high frequency words. More importantly, unlike English, fundamentally there is no reason to presume 'distinctive encoding' in Turkish for low frequency, late acquired words because of its extreme transparency. It is therefore hypothesized that

a main effect will emerge for AoA with early words better recalled than late acquired words together with an orthogonal frequency effect with high frequency better recalled than low frequency words.

The inclusion of picture stimuli in the study was a deliberate attempt to create a medium for free recall by totally eliminating the perplexing involvement from orthographic representations. In addition, pictures have been reported to have superiority over words in many lexical tasks including free recall (Paivio, 2007). A main effect is predicted for AoA in picture recall with early acquired items showing an overall advantage over late acquired pictures. Picture processing is assumed to be language independent and a significant AoA effect would be in line with the predictions of the semantic hypothesis where AoA effect is assumed to reside in the semantic system (Brysbaert et al, 2000). Similarly, pictures of high frequency are predicted to be better recalled compared to pictures of low frequency. In order to explore if list type has an impact on free recall, word and picture stimuli will be presented in pure and mixed lists (see DeLosh & McDaniel, 1996). In line with previous AoA reports in Turkish, it is hypothesized that pure lists will yield better recall scores for both word and picture stimuli.

Method

Design

The experiment employed a 2 (AoA: Early, Late) x 2 (Frequency: High, Low) x 2 (Stimulus type: Picture, picture name/word) x 2 (List type: pure, mixed) design in which AoA and Frequency were the within-subjects and the list and stimulus types were the between-subjects factors. In the first phase of the study, participants were asked to study the stimuli and subsequently, in the second phase, asked to recall as many items as possible. The total number of correctly recalled items was scored for analysis. Incorrectly recalled responses were recorded as errors.

Participants

Participants, 80 adults whose native language was Turkish, were recruited from the student population at Yeditepe University, Istanbul on a voluntary basis.

Materials

The experimental stimuli were selected from the recently developed Turkish colour picture norms (Raman, Raman & Mertan, 2014) and comprised of either the pictures or their equivalent picture names which were presented as words. Frequency measures were taken from the TS Corpus, the largest Turkish corpus online, containing 491 million POSTagged tokens (Sezer & Sezer, 2013). A total of 48 items, half of which were early acquired and the other half late acquired items were used. The early acquired items had an overall mean score of 1.6, SD=0.14, equating to items acquired by approximately 4 years of age. The late acquired items had a mean score of 3.15, SD=0.22, equating to items acquired by approximately 10 years of age. For example, *doll* <*bebek*> was early acquired (Mean = 1.38) whereas *hammer* <*çekiç*> was late acquired (Mean = 3.03). Furthermore, for the purpose of the study, there was an attempt to control for item frequency. High frequency items had a mean score of 68.9, SD=106 and low frequency items had a mean score of 2.35, SD=3.35. The comparison of early versus late acquired items was significant [$t(23)=27.8$, $p<0.000$] as was the comparison of high versus low frequency items [$t(23)=3.1$, $p<0.005$; see appendix for full stimuli set]. The mean letter length for high frequency items was 4.4 and for low frequency it was 6.5 indicating that low frequency items were approximately 2 letters longer. Subsequently, four experimental conditions were created as follows: i) early AoA (Mean=1.56, SD=0.13) high frequency (Mean=133, SD=120.41) ii) early AoA (Mean=1.65, SD=0.14) low frequency (Mean=4.41 SD=3.77) iii) late AoA (Mean=3.12, SD= 0.13) high frequency (Mean=4.84, SD=5.73) and iv) late AoA (Mean=3.19, SD=0.28) low frequency (Mean=0.29, SD=0.23). As can be seen from this data, one limitation was that conditions ii) and iii) had similar frequency scores,

however, it should be noted that the two conditions were not the focus of a direct comparison in the present study.

Procedure

The study was reviewed and approved by the Ethics Committees at Middlesex and Yeditepe Universities. Each participant was tested individually in a single session after giving informed consent in a quiet lab based within the Department of Psychology, Yeditepe University. The experiment consisted of a study phase during which the stimuli were presented, followed by a numerical distracter task (counting backwards from 999 by 3's) and finally a testing phase where participants were asked to recall as many items as possible from the study phase. The stimuli were presented as a PowerPoint presentation with each picture or picture name/word shown for 2000 ms followed by 2000ms interval before the next stimulus was presented. A total of 40 participants undertook the picture condition and another 40 participants the picture name/word condition. Furthermore, participants were randomly allocated to either a mixed list condition in which early and late acquired items were randomly mixed or a pure list condition in which early and late items were presented separately. The order of presentation of pure lists was counterbalanced to eradicate order effects. Participants were provided with a blank sheet of paper and asked to recall as many items as possible after the distracter task.

Results

Data were entered into the main analysis using a 2 (AoA: Early, Late) x 2 (Frequency: High, Low) x 2 (Stimulus type: Picture, picture name/word) x 2 (List type: pure, mixed) mixed ANOVA. Significant main effects were found for AoA [$F(1,76)=7.4$, $p<0.01$, $\eta^2=0.09$] and Frequency [$F(1,76)=61.2$ $p<0.0001$, $\eta^2=0.45$] but not for Stimulus Type [$F(1,76)<1$ $p> 0.05$, $\eta^2= 0.006$] nor List Type [$F(1,76)<1$ $p> 0.05$, $\eta^2= 0.005$]. In addition, significant two-way interactions were found between AoA and Stimulus Type [$F(1,76)=12.8$, $p<0.001$, $\eta^2=0.14$] and AoA and Frequency

[F(1,76)=37.9, p<0.0001, η^2=0.33] as well as Frequency and Stimulus Type [F(1,76) = 6.9, p<0.01, η^2=0.08]; a three-way interaction was found for AoA, Frequency and List Type [F(1,76)=5.9, p<0.01, η^2=0.07] as well as a marginal interaction between AoA, Frequency and Stimulus Type [F(1,76)= 3.8, p = 0.055, η^2=0.05] . None of the other interactions were significant. Detailed descriptive and inferential statistics together with post-hoc comparisons used to analyse the data are reported below; first under the pure list condition followed by the mixed list condition.

Insert Table 1 approximately here

Data were analysed once for words and once for pictures using a 2x2 ANOVA to examine the role of AoA and Frequency in the pure lists. As can be seen in Table 1 and Figures 1 and 3 in Table 2, both early and late acquired pictures and words were better recalled when they were of high frequency compared to low frequency items. The pure word list yielded a significant main effect for frequency [F(1,19)= 11.7 p<0.003, η^2= 0.381) with high frequency words (Mean= 9.3, SD= 3) recalled better than low frequency (Mean=6.8, SD= 2.5) words [t(19)=3.4, p<0.003) whereas the AoA effect was statistically nonsignificant [F(1,19)< 1, η^2= 0.001]. A significant interaction between AoA and Frequency was also found [F(1,19)=14.5 p< 0.001, η^2= 0.433] which was attributed to the pattern of results seen in Figure 1 in Table 2 with late acquired words for both high and low frequency displaying inverse patterns for recall. Post-hoc tests using Bonferroni corrected t-tests showed that the recall of early acquired high frequency words were significantly different to early acquired low frequency words [t(19)= 2.71 p<0.014] with none of the other comparisons reaching significance.

Significant main effects were found in the pure picture condition for both AoA [$F(1,19)= 6.8$, $p< 0.017$, $\eta^2= 0.263$] and Frequency [$F(1,19)= 30.1$, $p< 0.0001$, $\eta^2= 0.613$] with no interaction between AoA and Frequency (see Figure 3 in Table 2). In this respect, planned analyses showed that high frequency pictures (Mean=10.6, SD=3.9) were reliably better recalled than low frequency pictures (Mean= 6.7, SD= 3.2) [$t(19)= 5.5$, $p< 0.0001$]. Furthermore, early acquired (Mean= 9.6, SD= 4.0) pictures were better recalled than late acquired (Mean= 7.7, SD= 3.1) pictures with $t(19)= 2.6$, $p< 0.017$. Post-hoc tests showed that the source of the interaction is between early high and low frequency pictures [$t(19)= 3.23$ $p< 0.005$]; early high frequency and late low frequency pictures [$t(19)= 6.3$ $p<0.0001$] and late high frequency and low frequency pictures [$t(19)= 3.49$ $p< 0.002$].

Insert Table 2 (Figures 1- 4) here

Data were analysed once for words and once for pictures using a 2x2 ANOVA to further examine the role of AoA and Frequency on recall under the mixed list condition.

Data were entered into a 2 x 2 factorial ANOVA for words which showed a marginal main effect for Frequency [$F(1, 19)= 4$, $p< 0.06$, $\eta^2= 0.175$) but not for AoA [$F(1,19)<1$, $\eta^2= 0.021$]. As depicted in Figure 2, a significant interaction between AoA and Frequency was also found, $F(1,19)= 29.3$, $p<0.0001$, $\eta^2= 0.607$.

Post-hoc tests showed that the early acquired high and low frequency words were statistically significantly better recalled under the mixed list condition [$t(19)= 5.34$ $p< 0.0001$] as well as the early and late acquired low frequency words [$t(19)= 4.32$ $p< 0.0001$]. Late acquired high and low frequency words comparison also reached significance [$t(19)= 2.6$ $p< 0.02$] together with early and late high frequency words [$t(19)= 2.58$ 6 $p< 0.02$].

Formal analyses of the data using a 2x2 factorial ANOVA showed significant main effects for AoA [$F(1,19)= 51.2$, $p<0.0001$, $\eta^2= 0.729$] and Frequency [$F(1,19)=20.1$, $p<0.0001$, $\eta^2= 0.514$] for pictures in the mixed list condition as well as a significant interaction between the two variables [$F(1,19)=15.6$, $p<0.001$, $\eta^2= 0.452$] (see Figure 4 in Table 2).

Post-hoc tests showed that early acquired high frequency pictures were reliably better recalled compared to early acquired low frequency pictures [$t(19)= 5.2$, $p< 0.0001$]. Early and late high frequency pictures were found to be statistically different in the recall scores [$t(19)= 6.5$ $p< 0.0001$] with a similar finding for early high frequency and late low frequency picture recall [$t(19)= 7.5$ $p< 0.0001$]. None of the other comparisons reached significance.

Discussion

The aim of the current study was to examine the extent to which AoA and frequency affect word and picture free recall in pure vs mixed lists and to add to the limited body of literature with findings from Turkish. Results showed a significant main effect for AoA, and for Frequency but not for Stimulus or List Type. However, the interactions between AoA and Stimulus Type; AoA and Frequency; and AoA and Frequency and List Type were found to be statistically significant. None of the other interactions reached statistical significance.

The pattern of results for the pure word list condition showed a significant frequency effect, i.e., high frequency words recalled better than low frequency words, but there was no AoA effect. The finding that high frequency words were recalled better than low frequency words together with a null AoA effect in Turkish supports the findings reported by Dewhurst et al (1998) as well as findings reported by DeLosh and McDaniel (1996) for English in the pure list condition. Interestingly, Roodenrys, Hulme, Alban, Ellis, and Brown (1994) reported the same pattern of results in a short-term memory task in English. In addition, a significant interaction between AoA and

Frequency was also observed in Turkish with late acquired items for both high and low frequency displaying inverse patterns for recall, i.e. while performance on early acquired high frequency words was better than late acquired high frequency words, in contrast, late acquired low frequency word recall was better than early acquired low frequency words. When words were presented under the mixed list condition, a significant effect emerged for frequency with an advantage for high over low frequency words but not for AoA. This finding is in the opposite direction to the one reported by Dewhurst et al (1998) who found an advantage for low frequency, late acquired words in English. Similar to the pure word condition reported earlier, a significant interaction between AoA and Frequency was also found.

The different results observed for words under pure versus mixed lists is suggestive that list type influences word recall for late acquired words only depending on their frequency. The advantage of high over low frequency late acquired words under the mixed word list could be argued to reflect the increased task demands because of the unpredictability of the items in the list leading to the emergence of a word frequency effect as a facilitatory strategy adopted for successful recall. For late acquired words in pure lists where task demand is more homogenous and therefore less taxing, recall does not appear to be modulated by word frequency. These findings are in line with our previous reports in Turkish (Raman et al, 2004; Raman & Baluch, 2001) further confirming the use of differential strategies to help resolve conflict even in very transparent orthographies. Moreover, it could be argued that while in English the encoding features for lower frequency words are thought to be more 'distinctive' than the encoding features of high frequency words, in the absence of orthography-to-phonology irregularity in Turkish this advantage is reversed leading to the emergence of a word frequency effect under difficult experimental conditions.

Under the pure list condition, recall was significantly better when pictures were early acquired compared to late acquired, i.e. an AoA effect, and when pictures were high frequency than low frequency, i.e., a frequency effect. Under the mixed list condition, picture recall yielded a

significant AoA effect, i.e., early acquired high frequency pictures were reliably better recalled compared to early acquired low frequency pictures. However, statistically no significant difference was found for late acquired high and low frequency pictures. Finally, an effect was also found between early and late acquired pictures when they were of high frequency but not when they were of low frequency.

The pattern of results reported here for words under pure and mixed conditions appear to follow a comparable trend. That is, early acquired high frequency words were better recalled than late acquired high frequency words whilst late acquired low frequency word recall was better than early acquired low frequency words. On the contrary, picture recall produced different results altogether. In the mixed list condition, although high frequency pictures showed a similar trend to the pure list finding with better recall of early acquired pictures, low frequency pictures on the contrary were better recalled when they were late acquired. Overall, recall of early acquired, high frequency words and pictures outperformed all other conditions in both the pure and the mixed lists. In English, recall advantage for high frequency over low frequency words in pure lists has been long known with this effect often eliminated or reversed under mixed list condition (Dewhurst et al, 1998; DeLosh & McDaniel, 1996). Even though the impact of word frequency in pure vs mixed lists were reported in single word naming tasks in Turkish previously (Raman et al, 1996; Raman et al, 2004), this is nevertheless the first study that explores the impact of list type on free recall in Turkish using both AoA and Frequency as lexico-semantic variables. A comparison of Figures 1 and 2 for word stimuli under pure vs mixed conditions respectively yield as similar pattern of results. On the contrary, Figures 3 and 4 for picture stimuli clearly depict the impact of pure (4.8) vs mixed (3.2) lists respectively on recall. While the performance of participants on late acquired, low frequency words (3.45) vs pictures (3.2) appear comparable, this pattern of results were nevertheless contrary to our earlier prediction that participants would better recall pictures compared to words.

The pattern of results from the present study, i.e. the advantage for early acquired pictures over late acquired pictures in a free recall task in Turkish, adds further support to the body of evidence from lexical processing and memory tasks as well as the significant contribution of AoA in such tasks irrespective of language (Brysbaert et al, 2000; Dewhurst et al, 1998; Wilson et al, 2012; Bonin et al, 2002; Raman, 2006; 2011). Findings from the current study provide further support and are consistent with the claim that AoA is an integral part of lexical organisation. Given that picture processing is assumed to be language independent, the current findings are in line with the predictions of the semantic hypothesis (Brysbaert et al, 2000) and are taken to indicate that AoA is central in episodic encoding and therefore in the construction of episodic memory. Furthermore, the results show a trend for picture superiority effect on recall (Madigan, 2014; Paivio & Csapo, 1973) reported here in Turkish for the first time.

It is rather challenging to reconcile the current findings from Turkish with those reported in English in the absence of comparable recall data for pictures. Furthermore, only the mixed word condition in Turkish lends partial support to the account that 'more distinctive encoding of low-frequency and late-acquired words' could be the reason for late acquired, low frequency words performing on par with early acquired, high frequency words. One of the limitations in this respect has been the vague definition of the concept of 'distinctiveness' and hence the lack of its operationalisation and manipulation as a critical variable. It is therefore of theoretical interest for future research to examine the nature and source of 'distinctiveness' in transparent orthographies including Turkish and its role in free recall.

The results of this investigation pose a challenge for the arbitrary mapping hypothesis which suggests that AoA effects should be decreased for word naming in transparent orthographies. Juhasz (2005) suggests that this seemingly contradictory finding for Turkish (Raman, 2006) may be explained by an increased reliance on semantics in comparison with participants in other languages. The influence of semantics is thus proposed to occur as the consequence of activation cascading

forward from semantics to phonology in a highly interactive reading system (Balota et al., 2004; Raman & Baluch, 2001) and previously it has been argued that the contribution of semantics in Turkish increases with faster naming RTs (Raman & Baluch, 2001). To resolve this discrepancy, the mapping hypothesis must account for the nature of the semantic processing brought about by items with varying degrees of imageability. Alternatively, the multi-loci perspective contends that there are numerous, widely distributed, loci of AoA and word frequency effects (Ellis & Lambon Ralph, 2000; Izura et al., 2011).

Most recently, in a partial replication of the present study, research with monolingual Russian and bilingual Russian (L1) – English (L2) speakers (Volkovyskaya et al, in press) reported similar findings to Turkish and the findings were explained within the semantic hypothesis framework (Brysbaert and colleagues). This is most interesting given that Russian orthography is also phonologically more transparent than English (Volkovyskaya et al, in press). Where words are concerned, it therefore appears that orthographic transparency could play a pivotal part in the formation of episodic encoding in that 'distinctive encoding' could be an artefact or a function of orthographic transparency. Future research from other transparent orthographies could target and help resolve the debate between the findings from English versus Turkish and Russian.

One future direction for research on the basis of current findings is the extension of the study to evaluate the impact of AoA on recall in dyslexia in Turkish. Previously, adults with dyslexia showed a significant AoA effect in word and picture naming tasks similar to controls (Raman, 2011). It was concluded that AoA was a key variable in the organisation of the lexicon and that both dyslexics and nondyslexics utilise the lexical representations for words and the semantic representations for pictures in naming Turkish. Since lexical processing is assumed to be compromised in dyslexia due to phonological deficits as well as working memory problems (see Vellutino, Fletcher, Snowling & Scanlon, 2004 for a review), AoA could be vital to examine recall. It is important to note the similarity between previous research employing naming tasks in Turkish

and current findings although this could be considered conjectural because naming and free recall are two different tasks imposing different demands on the lexico-semantic system.

To conclude, the findings from Turkish suggest that early acquired, high frequency words and pictures have an advantage in free recall over early acquired, low frequency; late acquired, high frequency; and late acquired, low frequency words and pictures irrespective of list type. Furthermore, there is a clear indication that AoA and Frequency differentially influence episodic encoding and subsequent retrieval processes in the free recall task. However, the strategy employed in order to decipher visual stimuli such as words may be more reflective of processes modulated by orthographic transparency. This is the first report of such an effect in Turkish which partially supports findings reported in English by Dewhurst et al (1998). However, a solution to these paradoxical findings could be offered from an architectural perspective which better addresses the underpinning mechanisms that could be uniquely responsible for the development of episodic encoding and associated processes as a function of a specific orthography.

In this respect, further research needs to be carried out to verify and extend the findings reported here for Turkish and other writing systems and should include serial recall and recognition memory tasks in addition to free recall to better understand the relationship between episodic encoding and memory, declarative memory and the complex interplay of other contributing factors.

Furthermore, the findings have implications in applied fields such as neurodevelopmental learning difficulties, second language acquisition and clinical populations. The fact that AoA and frequency differentially affect the recall of word and picture stimuli under different task demands is suggestive that they are unlikely to be the product of the same underlying mechanism and can be used constructively and simultaneously to aid the development of the lexicon during the learning and/or encoding phase. We have previously reported that in word and picture naming tasks adult dyslexics in Turkish showed parallel results to a control group on AoA where early acquired items were advantageous to late acquired items (Raman, 2011). Finally, this was taken to indicate that the

same resources and mechanisms were utilised in the development of the lexicon. The role of AoA in the development of the bilingual lexicon has recently been documented for Russian (L1) - English (L2) speakers (Volkovyskaya et al, in press) as the 'ongoing construction of bilingual memory'. In this respect, L2 learning could be enhanced by the use of high frequency, early acquired words in L1 to facilitate the acquisition of low frequency, late acquired words in L2. Recently, both word frequency and AoA have been shown to correctly predict word recognition in Alzheimer's disease in Spanish (Cuetos, Arce, Martinez & Ellis, 2017). Given the similarity in orthographic transparency between Spanish and Turkish, it is of importance for future research in Turkish to be directed towards the investigation of independent effects of frequency and AoA in normal and clinical populations.

The current findings provide further evidence that AoA affects the visual object recognition and the lexical retrieval stages of lexical processing and that it is an inherent component of episodic memory irrespective of language.

References

Alario, F.-X., & Ferrand, L. (1999). A set of 400 pictures standardized for French: Norms for name agreement, image agreement, familiarity, visual complexity, image variability, and age of acquisition. *Behavior Research Methods, Instruments, & Computers*, 31, 531–552.

Balota, D. A., Cortese, M. J., Sergent-Marshall, S. D., Spieler, D. H., & Yap, M. J. (2004). Visual word recognition of single-syllable words. *Journal of Experimental Psychology: General, 133,* 283–316. doi: 10.1037/0096-3445.133.2.283

Barry, C., Hirsh, K. W., Johnston, R. A. & Williams, C. L. (2001). Age of acquisition, word frequency, and the locus of repetition priming of picture naming. *Journal of Memory and Language, 44*, 350-375.

Barry, C., Morrison, C. M., & Ellis, A. W. (1997). Naming the Snodgrass and Vanderwart Pictures: Effects of age of acquisition and naming agreement. *The Quarterly Journal of Experimental Psychology. 50A(3),* 560-585.

Bakhtiar, M., Nilipour, R., & Weekes, B. S. (2013). Predictors of timed picture naming in Persian. *Behavior Research Methods*.

Bonin, P., Chalard, M., Méot, A., & Fayol, M. (2002). The determinants of spoken and written picture naming latencies. *British Journal of Psychology, 93*, 89-114.

Brown, G. D., & Watson, F. L. (1987). First in, first out: Word learning age and spoken word frequency as predictors of word familiarity and word naming latency. *Memory & Cognition*, *15*(3), 208-216.

Brysbaert, M., Lange, M., & Wijnendaele, I. N. (2000). The effects of age-of-acquisition and frequency-of-occurrence in visual word recognition: Further evidence from the Dutch language. *European Journal of Cognitive Psychology, 12*(1), 65-85.

Carroll, J. B., & White, M. N. (1973). Word frequency and age of acquisition as determiners of picture naming latency. *Quarterly Journal of Experimental Psychology, 25,* 85-95.

Coltheart, V., & Winograd, E. (1986). Word Imagery but not age of acquisition affects episodic memory. *Memory and Cognition, 14*(2), 174-180.

Cortese, M. J., & Khanna, M. M. (2008). Age of acquisition ratings for 3,000 monosyllabic words. *Behavior Research Methods*, 40, 791–794.

Cortese, M. J., Khanna, M. M., & Hacker, S. (2010). Recognition memory for 2,578 monosyllabic words. *Memory*, 18(6), 595-609.

Cortese, M. J., McCarty, D. P., & Schock, J. (2015). A mega recognition memory study of 2897 disyllabic words. *The Quarterly Journal of Experimental Psychology*, 68(8), 1489-1501.

Cuetos, F., Arce, N., Martínez, C., & Ellis, A. W. (2017). Word recognition in Alzheimer's disease: Effects of semantic degeneration. *Journal of Neuropsychology*, *11*(1), 26-39.

DeLosh, E. L., & McDaniel, M. A. (1996). The role of order information in free recall: Application to the word-frequency effect. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *22*(5), 1136.

Dewhurst, S. A., Brandt, K. R., & Sharp, M. S. (2004). Intention to learn influences the word frequency effect in recall but not in recognition memory. *Memory & Cognition*, *32*(8), 1316-1325.

Dewhurst, S. A., Hitch, G. J., & Barry, C. (1998). Separate effects of word frequency and age of acquisition in recognition and recall. *Journal of Experimental Psychology: Learning, Memory and Cognition, 24*(2)*,* 284-298.

Ellis, A. W., & Lambon Ralph, M. A. (2000). Age of acquisition effects in adult lexical processing reflect loss of plasticity in maturing systems: insights from connectionist networks. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *26*(5), 1103.

Frederiksen, J. R., & Kroll, J. F. (1976). Spelling and sound: Approaches to the internal lexicon. *Journal of Experimental Psychology: Human Perception and Performance*, *2*(3), 361.

Ghyselinck, M., Custers, R., & Brysbaert, M. (2004). The effect of age of acquisition in visual word processing: Further evidence for the semantic hypothesis. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 30*(2), 550-554.

Gilhooly, K. J., & Gilhooly, M. L. M. (1979). Age-of-acquisition effects in lexical decision and episodic memory tasks. *Memory & Cognition, 7,* 214-223.

Gilhooly, K. J., & Gilhooly, M. J. (1980). The validity of age of acquisition ratings. *British Journal of Psychology, 71,* 105-110.

Gillund, G., & Shiffrin, R. M. (1984). A retrieval model for both recognition and recall. *Psychological Review*, *91*(1), 1.

Gregg, V. H., Montgomery, D. C., & Castaño, D. (1980). Recall of common and uncommon words from pure and mixed lists. *Journal of Verbal Learning and Verbal Behavior*, *19*(2), 240-245.

Hino, Y., & Lupker, S. J. (2000). Effects of word frequency and spelling–to–sound regularity in naming with and without preceding lexical decision. *Journal of Experimental Psychology: Human Perception and Performance*, *26*(1), 166.

Huang, Y. T., & Snedeker, J. (2011). Cascading activation across levels of representation in children's lexical processing. *Journal of Child Language, 38*(3), 644-661.

Izura, C., Pérez, M. A., Agallou, E., Wright, V. C., Marín, J., Stadthagen-González, H., & Ellis, A. W. (2011). Age/order of acquisition effects and the cumulative learning of foreign words: A word training study. *Journal of Memory and Language*, *64*(1), 32-58.

Johnston, R. A., & Barry, C. (2006). Age of acquisition and lexical processing. *Visual Cognition, 13,* 789-845.

Juhasz, B. J. (2005). Age-of-acquisition effects in word and picture identification. *Psychological Bulletin*, *131*(5), 684.

Lupker, S. J., Brown, P., & Colombo, L. (1997). Strategic control in a naming task: Changing routes or changing deadlines? *Journal of Experimental Psychology: Learning, Memory and Cognition, 23,* 570-590.

MacLeod, C. M., & Kampe, K. E. (1996). Word frequency effects on recall, recognition, and word fragment completion tests. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *22*(1), 132.

Madigan, S. (2014). Picture memory. *Imagery, memory and cognition*, 65-89.

McDaniel, M. A., Cahill, M., Bugg, J. M., & Meadow, N. G. (2011). Dissociative effects of orthographic distinctiveness in pure and mixed lists: An item-order account. *Memory and Cognition, 39*(7), 1162-1173.

Menenti, L., & Burani, C. (2007). What causes the effect of age of acquisition in lexical processing?. *The Quarterly Journal of Experimental Psychology*, *60*(5), 652-660.

Morris, P. E (1981). Age of acquisition, imagery, recall, and the limitations of multiple-regression analysis. *Memory and Cognition, 9,* 277-282.

Morrison, C. M., & Ellis, A. W. (1995). Roles of word frequency and age of acquisition in word naming and lexical decisions. *Journal of Experimental Psychology: Learning, Memory and Cognition, 21*(1), 116-133.

Morrison, C. M., Ellis, A. W., & Quinlan, P. T. (1992). Age of acquisition, not word frequency affects object naming, not object recognition. *Memory and Cognition, 20,* 705-714.

Paivio, A., & Csapo, K. (1973). Picture superiority in free recall: Imagery or dual coding?. *Cognitive Psychology*, *5*(2), 176-206.

Paivio, A. (2007). *Mind and its evolution: A dual coding theoretical approach.* Mahwah, NJ: Erlbaum.

Raman, I., Baluch, B., & Sneddon, P. (1996). What is the cognitive system's preferred route for deriving phonology from print? *European Psychologist*, *1*(3), 221-227.

Raman, I. (2006). On the age of acquisition effects in word naming and orthographic transparency: Mapping specific or universal? *Visual Cognition*, 13(7/8), 1044–1053.

Raman, I. (2011). The role of age of acquisition in picture and word naming in dyslexic adults. *British Journal of Psychology, 102,* 328–339.

Raman, I., Baluch, B., & Besner, D. (2004). On the control of visual word recognition: Changing routes versus changing deadlines. *Memory and Cognition, 32*(3), 489-500.

Raman, I., Raman, E., & Mertan, B. (2014). A standardized set of 260 pictures for Turkish: Norms of name and image agreement, age of acquisition, visual complexity, and conceptual familiarity. *Behavior Research Methods*, *46*(2), 588-595.

Roodenrys, S., Hulme, C., Alban, J., Ellis, A. W., & Brown, G. D. (1994). Effects of word frequency and age of acquisition on short-term memory span. *Memory & Cognition*, *22*(6), 695-701.

Sanfeliù, M. C., & Fernandez, A. (1996). A set of 254 Snodgrass–Vanderwart pictures standardized for Spanish: Norms for name agreement, image agreement, familiarity, and visual complexity. *Behavior Research Methods, Instruments, & Computers*, 28, 537–555.

Sezer, B., & Sezer, T. (2013). TS Corpus: Herkes için Türkçe Derlem. *Proceedings of the 27th National Linguistics Conference*. Antalya. Hacettepe University, Linguistics Department, 217-225.

Steyvers, M., & Tenenbaum, J. B. (2005). The Large-Scale Structure of Semantic Networks: Statistical Analyses and a Model of Semantic Growth. *Cognitive Science*, *29*(1), 41-78.

Strain, E., Patterson, K., & Seidenberg, M. S. (1995). Semantic effects in single-word naming. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *21*(5), 1140.

Tsaparina, D., Bonin, P., & Méot, A. (2011). Russian norms for name agreement, image agreement for the colorized version of the Snodgrass and Vanderwart pictures and age of acquisition, conceptual familiarity, and imageability scores for modal object names. *Behavior Research Methods*, *43*(4), 1085-1099.

Van Orden, G. C., Pennington, B. F., & Stone, G. O. (1990). Word identification in reading and the promise of subsymbolic psycholinguistics. *Psychological Review*, *97*(4), 488.

Vellutino, F. R., Fletcher, J. M., Snowling, M. J., & Scanlon, D. M. (2004). Specific reading disability (dyslexia): What have we learned in the past four decades?. *Journal of child psychology and psychiatry*, *45*(1), 2-40.

Volkovyskaya, E., Raman, I. & Baluch, B. (in press). Age of Acquisition (AoA) effect in monolingual Russian and bilingual Russian (L1) - English (L2) speakers in a free recall task. *Writing Systems Research*.

Weekes, B. S., Shu, H., Hao, M., Liu, Y., & Tan, L. H. (2007). Predictors of timed picture naming in Chinese. *Behavior Research Methods*, 39, 335–342.

Wilson, M. A., Cuetos, F., Davies, R., & Burani, C. (2013). Revisiting age-of-acquisition effects in Spanish visual word recognition: The role of item imageability. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *39*(6), 1842.

Wilson, M. A., Ellis, A. W., & Burani, C. (2012). Age of acquisition affects word naming in Italian only when stress is irregular. *Acta Psychologica, 139*, 417-424.

Zevin, J. D., & Seidenberg, M. S. (2002). Age of acquisition effects in word reading and other tasks. *Journal of Memory and Language*, *47*(1), 1-29.

	List type				
Stimuli type	Pure		Mixed		
	Mean	SD	Mean	SD	
Early, high frequency words	5.3	1.9	5.0	2.1	
Early, low frequency words	2.6	1.8	2.6	2.6	
Late, high frequency words	4.0	2.8	3.5	2.0	
Late, low frequency words	4.2	1.8	4.7	2.1	
Early, high frequency pictures	5.8	2.5	6.7	1.8	
Early, low frequency pictures	3.8	2.4	3.2	2.1	
Late, high frequency pictures	4.8	2.4	3.2	1.7	
Late, low frequency pictures	2.9	1.4	3.1	1.5	

Table 1. Mean and standard deviations of correctly recalled number of pictures and words in pure and mixed list conditions

Word and Picture Recall in Pure List	Word and Picture Recall in Mixed List
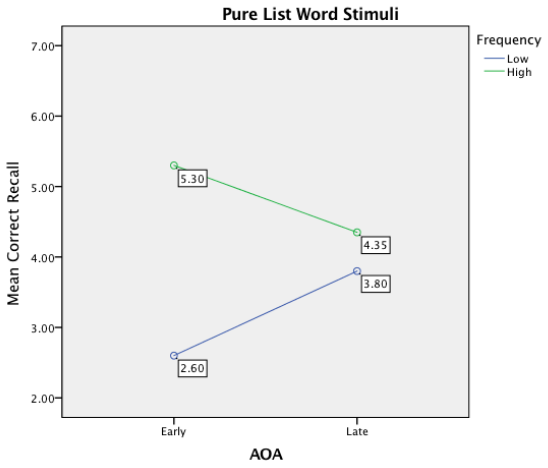	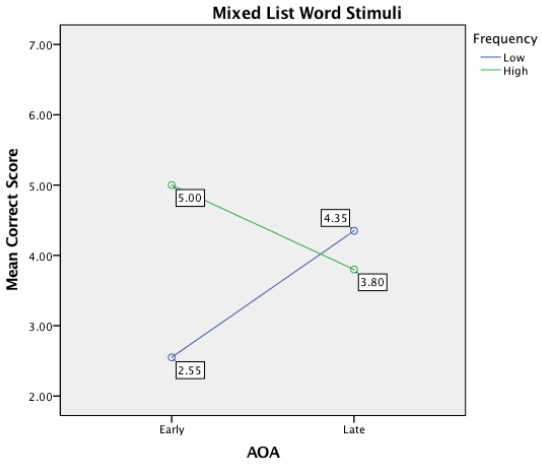
Figure 1: early vs late; high vs low frequency word recall in pure list	Figure 2: early vs late; high vs low frequency word recall in mixed list
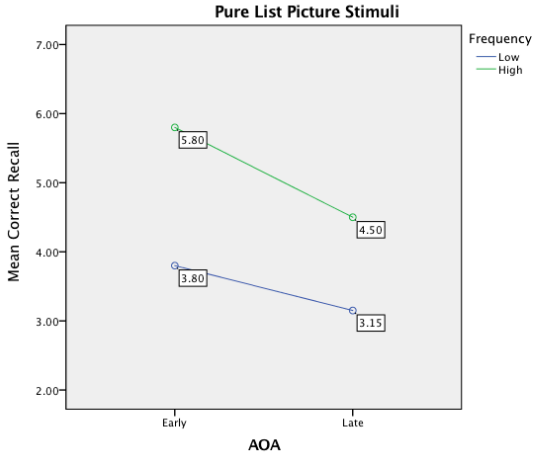	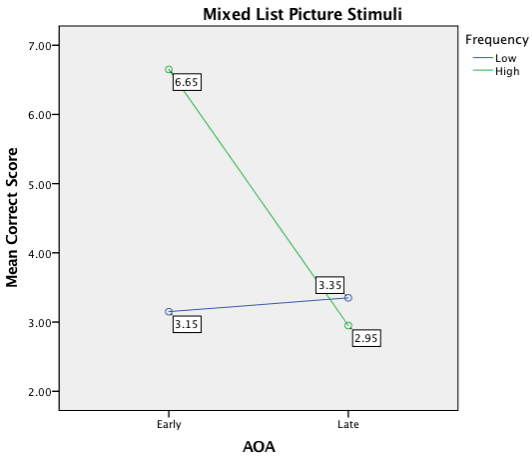
Figure 3: early vs late; high vs low frequency picture recall in pure list	Figure 4: early vs late; high vs low frequency picture recall in mixed list

Table 2. Graphs depicting mean correct recall for word and picture stimuli in pure vs mixed list conditions

Appendix

Experimental stimuli with corresponding AoA and Frequency measures (from Raman et al, 2014 and Sezer & Sezer, 2014, respectively)

Early AoA High Frequency				Late AoA High Frequency			
Turkish	English	AoA	Freq	Turkish	English	AoA	Freq
göz	eye	1.48	183.48	harp	harp	3.95	15.42
ay	moon	1.77	394.96	anahtar	wrench	3.00	0.07
el	hand	1.43	330.64	kilise	church	3.26	13.05
ev	house	1.56	182.48	piyano	piano	3.15	13.27
güneş	sun	1.51	125.23	rakun	raccoon	2.92	0.09
ayak	foot	1.41	52.45	çekiç	hammer	3.03	3.57
balık	fish	1.67	55.63	çapa	anchor	3.21	5.73
ağaç	tree	1.54	24.07	puro	cigar	3.25	2.21
ekmek	bread	1.62	41.69	flüt	flute	3.10	2.07
araba	car	1.59	40.76	vida	screw	3.02	1.3
bebek	doll	1.38	67.71	somun	nut	3.05	0.54
top	ball	1.75	96.95	pipo	pipe	3.38	0.73
MEAN SD		1.56 0.13	130.3 120.41	MEAN SD		3.12 0.13	4.84 5.73

Early AoA Low Frequency				Late AoA Low Frequency			
Turkish	English	AoA	Freq	Turkish	English	AoA	Freq
ampül	light bulb	1.75	0.17	tornavida	screwdriver	3.16	0.63
diş fırçası	toothbrush	1.70	1.06	gergedan	rhinoceros	3.21	0.49
kurşunkalem	pencil	1.74	0.21	akordeon	accordion	3.23	0.69
kase	bowl	1.66	2.02	trampet	trumpet	3.38	0.57
kep	cap	1.72	0.3	kül tablası	ashtray	2.90	0.17
dudak	lips	1.39	7.59	keski	chisel	3.31	0.20
arı	bee	1.59	9.13	top arabası	cannon	3.05	0.04
çorap	socks	1.79	6.77	yüksük	thimble	3.10	0.17
balon	balloon	1.38	5.36	yeldeğirmeni	windmill	3.07	0.14
muz	banana	1.62	5.92	törpü	nail file	3.02	0.13
armut	pear	1.77	3.33	pens	pliers	2.98	0.15
sandalye	chair	1.64	11.08	kokarca	skunk	2.97	0.09
MEAN		1.65	4.41	MEAN		3.19	0.29
SD		0.14	3.77	SD		0.28	0.23