Word Imageability and Orthographic Neighbourhood Effects on Memory: A study in Free Recall and Recognition

Claire Ballot, Stéphanie Mathey, & Christelle Robert

University of Bordeaux, France

Word count: 4677 words

Author Note

Correspondence concerning this article should be addressed to Claire Ballot, Univ. of Bordeaux, Laboratoire de Psychologie EA 4139, 3 place de la Victoire, F-33076 Bordeaux, France. Tel: +33 (0)5 57 57 18 71. Fax: +33 (0)5 57 57 71 55.

E-Mail: claire.ballot@u-bordeaux.fr

Abstract

This study investigated the effects of word imageability and orthographic neighbourhood size, as well as their combined effects, in free recall and recognition memory. A total of 45 young adults performed recall and recognition tasks on the same word materials. Word imageability and orthographic neighbourhood size were orthogonally manipulated across four word conditions: low-imageability words - high N, *saveur* [*flavor*], low-imageability words - low N, *total* [*total*], high-imageability words - high N, *carré* [*square*] and high-imageability - low N, *nuage* [*cloud*]. The results show that word imageability facilitates memory performance in both free recall and recognition tasks, while the effect of orthographic neighbourhood size was exhibited only in the recognition task. Finally, the orthographic neighbourhood effect was found to depend on word imageability. The implications of the results are discussed according to semantic and orthographic word characteristics with regard to the memory processes involved in free recall and recognition tasks.

Keywords: Free recall, recognition memory, word imageability, orthographic neighbourhood size.

Introduction

In recent decades, researchers have provided evidence suggesting that the semantic features of words influence word memory (e.g., Acheson et al., 2011). Other studies have addressed the effects of non-semantic word features, especially orthographic characteristics, and have also reported a critical influence on word memory performance (e.g., Glanc & Greene, 2012). Interestingly, the effect of semantic and orthographic properties could be dependent on the type of memory task (Cox et al., 2018; Lau et al., 2018; see also Balota & Yap, 2006 for similar arguments in the field of word recognition). Using a megastudy approach, Lau et al. (2018) showed that the structural features of words, namely their orthographical features, accounted for more variance in tasks driven by familiarity processes (i.e., recognition tasks), while semantic features accounted for more unique variance in tasks requiring more resources (i.e., recall tasks). Further to these findings, it is important to get a better understanding of how the effects of orthographic and semantic features combine to influence memory performance in both types of tasks. This was the aim of the present study.

Word imageability, defined as the ease with which a word evokes a mental image (e.g., Desrochers & Thompson, 2009), is usually used as a measure of the semantic richness of words (e.g., Yap et al., 2012). Word imageability has been found to be a strong predictor of memory performance (Cortese et al., 2010). The advantage of high-imageability words in memory performance can be explained in the dual-coding theory (e.g., Paivio, 1971, 1991) by assuming a dual representation of these words within two independent systems: a verbal (linguistic) and a non-verbal (imagistic) system (e.g., Strain et al., 1995 in a naming task). As regards the type of memory task, it has been observed that the influence of word imageability is more evident in recall (Rubin & Friendly, 1986) than in recognition tasks (Lau et al., 2018). As argued by Lau et al. (2018), this differential effect across memory tasks is due to the demands of the tasks. In particular, the semantic properties of words would have a greater

influence in more "demanding" memory tasks such as in recall because semantic richness is particularly useful for the processes of reconstruction of the degraded word trace after encoding or for the search processes in memory during retrieval (see also Poirier & Saint-Aubin, 1995). Retrieval being facilitated in recognition memory by the presence of a clue, the semantic features of words, such as word imageability, would play a weaker role in this memory task (Hunt & Eliott, 1980).

The orthographic features of words have also been found to influence memory performance, in particular through the study of orthographic distinctiveness (e.g., Cortese et al., 2004; Glanc & Greene, 2007, 2012). The concept of orthographic distinctiveness refers to the structural features of a word that make it physically unusual or interesting (Zechmeister, 1969). In other words, a word is distinct if it shares few or no characteristics with the other words in memory (Hunt & Eliott, 1980). Over the last few decades, orthographic distinctiveness has been operationalized by taking into account the lexical similarity of words, and in particular by considering orthographic neighbourhood size which corresponds to the number of words that can be formed by changing a single letter in the stimulus word (N index, Coltheart et al., 1977; see also Justi & Jaeger, 2017). For example, the orthographic neighbours of the word *sleet* are *sleep, fleet, sheet, skeet, sweet, slept, sleek* (N=7). In recognition memory, Glanc and Greene (2007, 2012) found a mirror effect of N with a decrease in hit rates and an increase in false alarm rates for high-N words compared to low-N words (see also Cortese et al., 2004; Freeman et al., 2010; Heathcote et al., 2006; Justi & Jeager, 2017; Kang et al., 2009). Because high-N words share many sublexical components with other words in memory, they are less distinctive than low-N words, and so they are more difficult to retrieve in memory (Cortese et al., 2004; Glanc & Greene, 2007). Orthographic distinctiveness, and in particular the number of orthographic neighbours, is an important factor to consider when conducting research in the field of word memory, especially in

recognition memory tasks where word retrieval involves familiarity processes that are highly sensitive to the structural properties of words (Lau et al., 2018). Memory tasks that require more effortful retrieval processes would be less sensitive to the orthographical features of words (Hunt & Eliott, 1980). Interestingly, in their work on orthographic neighbourhood effects in a recognition task, Glanc and Greene (2007) found that the N effect was no longer observed when encoding instructions were driven by the semantic aspects of words (i.e., when questions were asked about the meanings of words). This was taken as evidence that the semantic processing of words could overcome the effects of orthographic distinctiveness in memory. The question of whether and to what extent the orthographic and semantic properties of words exert a mutual influence on free recall and recognition is therefore important to address. Also, since N effects in memory are now well-established in English, it is important to clarify such effects in French, a language whose N effects reputedly have greater difficulty appearing in visual recognition (Andrews, 1997).

The aim of present study was to examine the effects of word imageability and orthographic neighbourhood on free recall and recognition and to specify how and to what extent these effects might combine in both memory tasks. As suggested by Lau et al. (2018), human memory is flexible enough to adapt to the word features as well as to the constraints of the task in order to optimise performance. In that sense, word properties play an important role in memory performance, but this role depends on the type of properties and on the type of memory task. Semantic features improve the effortful search and reconstruction processes underlying the recall task to a greater extent, whereas orthographic features further impact the familiarity processes that underlie recognition memory performance. An important issue that remains to be addressed here is the mutual influence of semantic and orthographic characteristics on memory with regard to the two types of memory tasks in order to specify common and task-specific processes related to word properties in word memory. We

hypothesised that word imageability enhances memory performance, especially in the free recall task which involves more demanding search and reconstruction processes during retrieval (Hunt & Eliott, 1980; Lau et al., 2018). In line with previous studies (Glanc & Greene, 2007, 2012), we expected words with a high N to exhibit a lower memory performance than words with a low N, especially in the recognition memory task where the structural properties of words are more prominent (Lau et al., 2018). Moreover, the effect of orthographic neighbourhood might also be sensitive to word imageability, such that the N effect could be reduced for highly imageable words whose semantic aspects are more prominent. To test these hypotheses, we orthogonally manipulated word imageability and the number of orthographic neighbours in two long-term memory tasks that are widely used in the literature (i.e., free recall and recognition). As already stated, these two tasks can help to disentangle common and task-specific effects of word features in order to provide a better understanding of the cognitive processes underlying word memory performance.

Method

Participants

A total of 45 undergraduate students *(M_{age} = 23.01 years, SD_{age}= 3.19)* took part in the experiment. They were all native French speakers and reported having normal or corrected-to-normal vision. All participants provided voluntary informed consent prior to participation.

Materials

The stimuli were 80 words of 4 to 7 letters selected from the lexical database of Desrochers and Thompson (2009), which provides imageability and subjective word frequency ratings for a corpus of French words. Other characteristics were taken from the French lexical database Lexique 3.8 (New et al., 2007). Half of the words had a high N (N >

6) while the other half had a low N (N < 3, for a similar procedure see Glanc & Greene, 2007), p <.001. In each of these two orthographic neighbourhood conditions, half of the words were highly imageable (scores above 3.5 on the 7-point scale proposed by Desrochers & Thompson, 2009) and the other half were low-imageability words (scores below 3.5 on the 7-point scale), p <.001. In summary, the materials consisted of 20 low-imageability words with a high N (e.g., saveur [*flavor*]), 20 low-imageability words with a low N (e.g., total [*total*]), 20 high-imageability words with a high N (e.g., carré [*square*]) and 20 high-imageability words with a low N (e.g., nuage [*cloud*]).

The four word conditions were matched on subjective word frequency, objective word frequency (in occurrences per million), number of syllables and number of letters (ps > .10). The main statistical characteristics of the materials are presented in Table 1.

Insert Table 1

Four mixed lists of 20 stimuli were drawn up so that each list contained 5 words per experimental condition. For the purpose of the recognition task, 80 French words that had lexical characteristics similar to those of the experimental words were selected as distractors.

Procedure

Participants were tested individually in a quiet room and performed a free-recall task after providing written consent. The task was controlled by a personal computer using the E.Prime 2.0 software. During the study phase, participants were instructed to memorise the words presented one by one. Each word appeared in lowercase in the centre of a computer screen for 3,000 ms and was preceded by a 1000-ms fixation cross. At the end of the list, a

screen instruction required each participant to count down for 30 seconds. Next, participants had to write the words they remembered on a sheet of paper. No time limit or recall order constraints were imposed for recall. Immediately afterward, another list appeared and the procedure was replicated. The presentation of the words was randomised within each list and the list appearance order was counterbalanced across participants to control for list order effects. Following the four study and recall phases, participants performed a recognition task (for a similar procedure see Lohnas & Kahana, 2013). In the recognition task, 160 words were presented on the computer screen, in a different random order for each participant. The 80 words from the previous recall task were mixed with 80 new words used as distractors. Participants were asked to decide whether each word appearing on the screen was "new" or "old" by pressing one of the two buttons on the computer keyboard. The buttons were tailored to the participant's laterality so that they would respond "old" with the dominant hand and "new" with the other hand. The words were preceded by a 1000-ms fixation cross and remained on the screen until the participant responded.

Results

Separate analyses of variance (ANOVAs) were performed on hits for recall, hits for recognition memory, false alarms, and on an index of sensitivity (*d'*) based on the hits and false alarms in order to assess recognition memory performance, with N and word imageability as within-subject factors. Two words identified as outliers (|SDR| > 4) were excluded. The results are shown in Table 2.

Free Recall

The analysis of hits showed a significant effect of word imageability, $F(1, 44) = 37.87$, $p < .001$, $\eta^2p = .46$. High-imageability words were recalled better ($M = .44$) than low-

imageability words (*M* =.35). No significant effect of N was found, $F < 1$. Importantly, the interaction between word imageability and N was significant, $F(1, 44) = 7.91$, $p = .007$, $\eta^2p = .15$. More precisely, the effect of N was significant for low-imageability words, $F(1, 44) = 4.49$, $p = .04$, $\eta^2p = .09$, showing that high-N words were recalled less (*M* = .33) than low-N words (*M* = .38). No significant effect of N was found for high-imageability words, $F(1, 44) = 3.01$, $p = .09$, $\eta^2p = .06$.

Recognition

The analysis of hit rates showed a significant effect of word imageability, $F(1, 44) = 17.07$, $p < .001$, $\eta^2p = .28$. High-imageability words were recognised better (*M* =.79) than low-imageability words (*M* =.74). A significant effect of N was also found, $F(1, 44) = 15.17$, $p < .001$, $\eta^2p = .26$. High-N words were recognised less (*M* = .74) than low-N words (*M* = .79). Finally, the interaction between word imageability and N was significant, $F(1, 44) = 4.48$, $p = .04$, $\eta^2p = .09$. More precisely, a significant N effect was found for low-imageability words, $F(1, 44) = 15.10$, $p < .001$, $\eta^2p = .26$, showing that low-imageability words with high N were recognised less (M = .70) than low-imageability words with low N (M = .78). The N effect was not significant for high-imageability words, $F(1, 44) = 1.85$, $p = .18$.

Concerning false alarm rates, a significant effect of word imageability was found, $F(1,43) = 10.73$, $p = .002$, $\eta^2p = .19$. Low-imageability words exhibited fewer false alarms (*M* = .08) than high-imageability words (*M* = .11). The N effect was not significant $F < 1$. We found a significant interaction between word imageability and N, $F(1, 44) = 9.18$, $p = .004$, $\eta^2p = .17$. The N effect was significant for low-imageability words, $F(1, 44) = 4.08$, $p = .049$, $\eta^2p = .09$, showing that low-imageability words with high N exhibited more false alarms (*M* = .09) than low-imageability words with low N (*M* = .07). The N effect was also reliable for high-imageability words, $F(1, 44) = 4.16$, $p = .047$, $\eta^2p = .09$, showing that high-imageability words with high N produced fewer false alarms (*M* = .09) than words with low N (*M* = .12).

Concerning *d'* values, no significant effect of word imageability was found, $F(1, 44) = 1.29$, $p = .26$. The N effect was significant, $F(1,44) = 7.59$, $p = .009$, $\eta^2p = .15$. High-N words were discriminated less well ($M = 2.24$) than low-N words ($M = 2.41$). Finally, the interaction effect between word imageability and N was significant, $F(1,44) = 9.89$, $p = .003$, $\eta^2p = .18$. The N effect was significant for low-imageability words, $F(1, 44) = 22.18$, $p < .001$, $\eta^2p = .33$, showing that low-imageability words with a high N were discriminated less well ($M = 2.09$) than low-imageability words with a low N ($M = 2.49$). No N effect was found for high-imageability words, $F < 1$.

Insert Table 2

Discussion

The aim of the present study was to investigate the main and combined effects of word imageability and orthographic neighbourhood in free recall and recognition tasks. The main findings can be summarised as follow. An effect of word imageability was found on both free recall and recognition memory while the effect of orthographic neighbourhood was evident in the recognition task and not in free recall. Moreover, the effect of orthographic neighbourhood was found to depend on word imageability in both free recall and recognition. These results are discussed in terms of the common and task-specific processes involved in word memory performance.

Effects of word imageability and orthographic neighbourhood on free recall and recognition

Overall, the results clearly showed that high-imageability words were recalled better and recognised better than low-imageability words. These findings are in line with previous ones from studies that used free recall (Rubin & Friendly, 1986) or recognition (Cortese et al., 2010) tasks. The memory advantage of high-imageability words can be ascribed to their semantic richness that would enhance their retrieval in memory, whatever the task is. It is important to note here that semantic richness also makes words less distinctive in memory because they share multiple semantic features with other words (Lau et al., 2018). In the present study, the increase in false alarms observed for high-imageability words compared to low-imageability words supports the idea of a difficulty in discriminating high-imageability words because of their semantic richness. The effects of word imageability could also be accounted for by the dual-coding theory (Paivio, 1971, 1991) which posits that high-imageability words benefit from a dual coding in a verbal and a non-verbal system in comparison with low-imageability words, which benefit from a coding in a single verbal system. Although the effect of word imageability was observed in both tasks, it explains more variance for the hit rates in recall than in recognition (respectively 46% vs. 28%), which is fully consistent with findings from previous megastudies that have suggested a higher influence of the semantic features of words in effortful and resource-demanding memory tasks (Hunt & Eliott, 1980; Lau et al., 2018). Therefore, common memory processes might underlie imageability effects in both recall and recognition tasks but to various extents, with a stronger role of semantics in recall than in recognition. Note that, in agreement with the procedure used by Lohnas and Kahana (2013), the recognition task always followed the free recall task in the present study. The interest here was that the recall performance was comparable to that of previous studies in which the participants recalling the words did not

perform any recognition previously (e.g., Cortese et al., 2004; Rubin & Friendly, 1986). As a consequence of this constant task order, we cannot however reject the hypothesis that word recall might have enhanced encoding, therefore facilitating subsequent word recognition. Future studies should be designed to investigate this issue further.

In contrast to the imageability effect that clearly occurred in both memory tasks, we found that the influence of orthographic similarity on memory depended on the task. Although the orthographic neighbourhood effect failed to emerge in free recall, the N effect was evident in recognition. More precisely, low-N words were recognised better and discriminated better than high-N words. In line with results from previous studies (Cortese et al., 2004; Glanc & Greene, 2007, 2012 in English; Justi & Jaeger, 2017 in Portuguese), these latter findings confirm that orthographic distinctiveness plays an important role in recognition memory and extend this conclusion to the French language. Our result showing that the N effect was confined to the recognition task suggests that the influence of orthographic properties is favored by recognition-specific processes. As suggested in previous studies (e.g., Goh & Lu, 2012), the cue provided in the recognition task is less diagnostic if it shares components with multiple traces. By extending this assumption to neighbourhood effects, words with few orthographic neighbours would be more easily recognised when they present a clue during the memory recognition task, since they share no or few orthographic characteristics with other words stored in memory. Conversely, clues relating to words with a high N would be more difficult to associate with a trace in episodic memory because of their orthographic resemblance to many other words stored in memory.

Combined effect of word imageability and orthographic neighbourhood on free recall and recognition

Another important purpose of this study was to determine whether word imageability and orthographic neighbourhood exert a combined influence in memory tasks. The results showed that the effect of orthographic neighbourhood was sensitive to imageability in both free recall and recognition. Concerning low-imageability words, high-N words were both recalled less and recognised less than low-N words. When false alarms were considered in the recognition task, a mirror effect of N was observed for low-imageability words. High-N words were discriminated less well than low-N words when their imageability was low. For high-imageability words, the effect of orthographic neighbourhood was no longer observed on recall and recognition memory. This pattern of results in both free recall and recognition suggests that semantic and orthographic factors are interdependent in different memory tasks (Hunt & Eliott, 1980; Nishiyama et al., 2017) and that their mutual intervention relies on shared memory processes. More precisely, when access to the semantic information in the word is high (as is the case for high-imageability words), the semantic rather than the orthographic features are preferentially used during the processes of recollection. Conversely, when few semantic characteristics are available (as is the case for low-imageability words), the orthographic properties of words could be used during the processes of recollection. These findings can also be accommodated by the dual-coding theory (Paivio, 1971, 1991). In this framework, low-imageability words would be coded in a verbal system only, which would allow for the orthographic neighbourhood to influence the processing of the word. For high-imageability words, the dual coding within a linguistic and an imagistic system would privilege the coding of semantic and imagistic information in the words, in this case word imageability. As already mentioned, the general increase in false alarms for these words might be due to their semantic richness which makes them less distinctive in memory. Also note that

for high-imageability words, the rate of false alarms was lower for high-N words than for low-N words. For these high-imageability words, it is therefore possible that access to semantic information depends to some degree on orthographic neighbourhood. Interference from neighbours could delay access to semantic information for high-N words whereas access to semantic information would be easier for low-N words. This phenomenon would be restricted to false alarms because the processes underlying the production of false alarms would be different from those underlying the hits (e.g., see Yonelinas, 2002).

Conclusion

In summary, this study provides additional arguments that should help to shed more light on the issue on the semantic and orthographic characteristics that underlie common and specific processes involved in memory tasks. First, the imageability effect suggests that the semantic features of words are used in both recall and recognition tasks but to a greater extent in the recall task, which implies more effortful and resource-demanding processes of recollection. Second, the effect of orthographic neighbourhood size, which only emerged in the recognition task, rather suggests that orthographic features are mainly useful in tasks driven by familiarity processes. Furthermore, the semantic and orthographic properties of words produced a combined influence on both free recall and recognition, highlighting their interdependent role in memory. In particular, word retrieval processes would be influenced by the orthographic features of words only when semantic information is not or is barely available. Such common and specific effects of semantic and orthographic properties across memory tasks suggest that human memory is flexible and is able to adapt to the features of words as well as to the constraints of the task in order to optimise memory performance (see also Cox et al., 2018; Lau et al., 2018). Further studies should be designed to clarify the specific and common influence of word properties on memory by using several other memory tasks and by manipulating the context of encoding.

Disclosure statement

No potential conflict of interest was reported by the authors.

References

Acheson, D. J., MacDonald, M. C., & Postle, B. R. (2011). The effect of concurrent semantic categorization on delayed serial recall. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *37*, 44–59.

Balota, D. A., & Yap, M. J. (2006). Attentional control and flexible lexical processing: Explorations of the magic moment of word recognition. In S. Andrews (Ed.), *From inkmarks to ideas: Current issues in lexical processing* (pp. 229–258). New York, NY: Psychology Press.

Coltheart, M., Davelaar, E., Jonasson, J.F., & Besner, D. (1977). Access to the internal lexicon. In S. Dornic (Ed.), *Attention and Performance VI* (pp. 535-555). Hillsdale, N.J.: Erlbaum.

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

Cortese, M. J., Watson, J. M., Wang, J., & Fugett, A. (2004). Relating distinctive orthographic and phonological processes to episodic memory performance. *Memory & Cognition*, *32*(4), 632-639.

Cox, G. E., Hemmer, P., Aue, W. R., & Criss, A. H. (2018). Information and processes underlying semantic and episodic memory across tasks, items, and individuals. *Journal of Experimental Psychology: General*, *147*(4), 545–590.

Desrochers, A., & Thompson, G. L. (2009). Subjective frequency and imageability ratings for 3,600 French nouns. *Behavior Research Methods*, *41*(2), 546-557.

Freeman, E., Heathcote, A., Chalmers, K., & Hockley, W. (2010). Item effects in recognition memory for words. *Journal of Memory and Language*, *62*(1), 1-18.

Glanc, G. A., & Greene, R. L. (2007). Orthographic neighborhood size effects in recognition memory. *Memory & Cognition*, *35*(2), 365-371.

Glanc, G., & Greene, R. (2012). Orthographic distinctiveness and memory for order. *Memory*, *20*(8), 865-871.

Goh, W. D., & Lu, S. H. (2012). Testing the myth of the encoding–retrieval match. *Memory & cognition*, *40*(1), 28-39.

Heathcote, A., Ditton, E., & Mitchell, K. (2006). Word frequency and word likeness mirror effects in episodic recognition memory. *Memory & Cognition*, *34*(4), 826-838.

Hunt, R. R., & Elliot, J. M. (1980). The role of nonsemantic information in memory: Orthographic distinctiveness effects on retention. *Journal of Experimental Psychology: General*, *109*(1), 49-74.

Justi, F. R., & Jaeger, A. (2017). Orthographic neighborhood effects in recognition and recall tasks in a transparent orthography. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *43*(4), 565-578.

Kang, S. H., Balota, D. A., & Yap, M. J. (2009). Pathway control in visual word processing: Converging evidence from recognition memory. *Psychonomic bulletin & review*, *16*(4), 692-698.

Lau, M. C., Goh, W. D., & Yap, M. J. (2018). An item-level analysis of lexical-semantic effects in free recall and recognition memory using the megastudy approach. *Quarterly Journal of Experimental Psychology*, *71*(10), 2207-2222.

Lohnas, L. J., & Kahana, M. J. (2013). Parametric effects of word frequency in memory for mixed frequency lists. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *39*(6), 1943–1946.

Nishiyama, R., Hirano, T., & Ukita, J. (2017). Usage of semantic representations in recognition memory. *Memory*, *25*(10), 1412-1424.

New, B., Brysbaert, M., Veronis, J., & Pallier, C. (2007). The use of film subtitles to estimate word frequencies. *Applied psycholinguistics*, *28*(4), 661-677.

Paivio, A. (1971). *Imagery and verbal processes*. New York: Holt, Rinehart & Winston.

Paivio, A. (1991). Dual coding theory: Retrospect and current status. *Canadian Journal of Psychology/Revue canadienne de psychologie*, 45(3), 255-287.

Poirier, M., & Saint-Aubin, J. (1995). Memory for related and unrelated words: Further evidence on the influence of semantic factors in immediate serial recall. *The Quarterly Journal of Experimental Psychology Section A*, *48*(2), 384-404.

Rubin, D. C., & Friendly, M. (1986). Predicting which words get recalled: Measures of free recall, availability, goodness, emotionality, and pronunciability for 925 nouns. *Memory & Cognition*, *14*(1), 79-94.

Strain, Eamon; Patterson, Karalyn; Seidenberg, Mark S. (1995). *Semantic effects in single-word naming. Journal of Experimental Psychology: Learning, Memory, and Cognition, 21(5), 1140–1154.*

Yap, M. J., Pexman, P. M., Wellsby, M., Hargreaves, I. S., & Huff, M. (2012). An abundance of riches: cross-task comparisons of semantic richness effects in visual word recognition. *Frontiers in Human Neuroscience*, *6*, 72-82.

Yonelinas, A. P. (2002). The nature of recollection and familiarity: A review of 30 years of research. *Journal of Memory and Language*, *46*(3), 441-517.

Zechmeister, E. B. (1969). Orthographic distinctiveness. *Journal of Verbal Learning and Verbal Behavior*, *8*(6), 754-761.