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Differences between Bilinguals and Monolinguals in False Memory Production? A Look into the DRM Paradigm Using Contextual Details

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Abstract
This study compared false memory production in Spanish monolinguals and Spanish-Catalan bilinguals. We used an adjusted Deese-Roediger-McDermott (DRM) false memory paradigm and presented the participants with eight Spanish DRM lists containing 12 words each, along with figures and colors to manipulate contextual details. Free recall results showed higher true recall levels in bilinguals than in monolinguals. However, we did not find notable false memory differences between the monolinguals and bilinguals. We found no differences in the amount of contextual details added in the true and false recall, indicating that levels of confidence in memories are similar in the two groups. Implications of the findings are discussed.

Keywords
Bilingualism, Contextual details, False memory, and DRM paradigm

The phenomenon of false memory refers to the remembering of an event or detail that either never happened or happened quite differently from reality (Roediger & McDermott, 1995). Empirical studies of false memory increased during the 1990s when people started to form false memories after suggestive therapeutic techniques (Lindsay & Read, 1995). Based on these false memories, innocent people were falsely accused of sexual abuse, pointing to the importance of gaining a deeper understanding of false memories.

One method that has been used to study the formation of false memories is the Deese-Roediger-McDermott (DRM) paradigm (Roediger & McDermott, 1995). In the DRM paradigm, word lists are presented that contain associatively-related words. For example, water, stream, and lake are associated with the critical lure river. Research has shown that in both free recall and recognition tasks, participants indicate they remember the critical lure with high confidence, known as false memories (Gallo, McDermott, Percer, & Roediger, 2001). In this study, we performed an experiment to examine true and false memory production in monolinguals and bilinguals.

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False Memory Theories

Several theoretical frameworks explain the occurrence of false memories: Activation-Monitoring Theory (AMT) (Roediger, Watson, McDermott, & Gallo, 2001), Fuzzy Trace Theory (FTT) (Brainerd, Reyna, & Ceci, 2008), and the Associative Activation Theory (AAT) (Howe, Wimmer, Gagnon, & Plumpton, 2009). AMT and AAT postulate that during the experience of an event, concepts are activated that are related to each other. During this spreading activation, sometimes concepts are activated that are related but not experienced, leading to false memories. This activation of the critical lure increases

the likelihood that it will be recalled in a subsequent memory task (Roediger, Watson, McDermott, & Gallo, 2001).

FTT (Brainerd et al., 2008; Brainerd & Reyna, 2002) posits that memories are stored in the form of verbatim and gist memory traces. The verbatim trace of memory refers to specific details of an experience, such as contextual cues that can allow for distinctions between memories. An example of this is the font in which the words of the DRM are presented or the number of phonemes in a word. On the other hand, gist memory traces involve the storing of the underlying meaning of an experience (Brainerd & Reyna, 2002). FTT stipulates that false memories are formed when a person relies on gist information and no verbatim traces can be retrieved (Arndt, 2010).

The occurrence of false memory has important implications in the judicial system, such as the aforementioned example of alleged sexual abuse. Given that over half the world population is bilingual (Grosjean, 2008), with higher numbers of bilinguals in urban areas compared to rural ones (Bialystok, Craik, & Luk, 2012), and that urbanization is expected to increase from 55% to 68% ("68% of the world population," 2018), it is important to study bilinguals in urban societies. It is thus of interest whether the production of false memories differs between monolinguals and bilinguals. Specifically, it is relevant to understand whether bilinguals produce more or fewer false memories and whether the first or second language could impact false memory production.

False Memories in Bilinguals

Previous research on monolinguals of different languages using the DRM paradigm has indicated that the false memory effect remained, for example, in Spanish (García-Barjos & Migueles, 1997; Pérez-Mata, Read, & Diges, 2002) and Portuguese (Stein & Pergher, 2001). This allowed for follow-up research on bilinguals and the production of false memories. Miyaji-Kawasaki, Inou, and Yama (2003) studied false memory differences in Japanese-English bilinguals for whom Japanese was the dominant language. The participants were shown 12 DRM lists, six in English and six in Japanese. Next, they took a recognition test in both languages (Miyaji-Kawasaki, Inoue, & Yama, 2003). The rate of correct recognition was higher when the languages were the same in the encoding and test phase; however, false recognition occurred more frequently when the recognition test was given in Japanese, independently of whether the encoding and test language matched. The researchers argued that, since Japanese was the participants' dominant language, this allowed for simpler translation and a greater associative network, which resulted in the higher false recall when Japanese was used for the recognition test.

A follow-up study delved into false memory in Spanish-English bilinguals. DRM lists were modified to Spanish to gain equal associative strengths between the English and Spanish lists (Anastasi, Rhodes, Marquez, & Velino, 2005). In several experiments, comparisons were made between bilingual participants' performance in their dominant and non-dominant languages, which were, in turn, compared to monolinguals' performance in either language. The participants were shown DRM lists in either their dominant or non-dominant language and then completed a recognition task in either language. When stimuli were presented and tested in the monolinguals' language, then both true and false recognition rates were higher. In contrast, bilinguals' false recognition rate increased when materials were presented in their non-dominant language. This could be explained by other research that explains that native-language lexical activation is present during a second language task, which, in combination, could increase false memory recognition (Thierry & Wu, 2007). Further research is necessary to explore this. Relatedly, Sahlin, Harding, and Seamon (2005) provided different recognition versions to Spanish-English bilingual participants in either the studied language or another language. They found that when the recognition test was provided in the same language as the language of the DRM lists, false recognition increased compared to when the recognition test was presented in the other language.

Thus, the previous studies indicate that the production of false memories depends on the language in which stimuli are presented and tested. According to these studies, it is more difficult to extract the gist of word lists when switching languages, resulting in lower true and false memory levels. A related study by Mar-

molejo, Diliberto-Macaluso, and Altarriba (2009) examined Spanish-English bilinguals using the DRM paradigm. The participants have presented a DRM list in either English or Spanish and then asked to do a free recall task in English or Spanish, followed up by a recognition task in both languages. Correct and false recall rates were higher when they were asked in their dominant language, as long as the language of encoding and test were identical. Further, false recall, recognition, and recognition confidence seemed to increase when the studied items were in a different language than the test items. This indicates, again, that the language in which information is encoded, recalled, or recognized has an impact on false memory formation.

A somewhat contradicting study by Howe, Gagnon, and Thouas (2008) examined differences in bilinguals in the DRM paradigm, while also looking at age differences. Children aged 6 to 12 and adults were given DRM lists. The lists were either within (English-English or French-French) or between (English-French or French-English) languages. Afterwards the participants performed a free recall and recognition task. The youngest children's group (age 6 years) showed results identical with those of previous studies (Sahlin et al., 2005; Anastasi et al., 2005; Marmolejo et al., 2009) in that false memories were higher in the within language condition, while the adult groups showed an increase in false memories in the between language condition. The findings on true memory were in line with previous research (Miyaji-Kawasaki et al., 2003; Sahlin et al., 2005; Anastasi et al., 2005; Marmolejo et al., 2009), as it increased when it was tested within languages. This indicates that further research is necessary to gain a clear knowledge of the effects of languages on false memories.

It is interesting that bilinguals using their dominant language impacts false memory formation, even though this effect disappears when compared to monolinguals of either language (Anastasi et al., 2005). As mentioned, other research explains that native-language lexical activation is present during a second language task (Thierry & Wu, 2007), which could indicate an increased associated activation, due to other language influences, in bilinguals. This could explain the increase in false recognition in bilinguals (Anastasi et al., 2005; Marmolejo et al., 2009; Sahlin et al., 2005). These findings led to the main focus of the current study, in which we compared bilingual Spanish-Catalan speakers, with dominance in Spanish, to monolingual Spanish speakers. Our prediction was that, due to similarity in the lexical and semantic information between the languages spoken by the bilingual Spanish-Catalan speakers, there would be a greater associative network, which would increase false memory.

As a subsidiary aim of this study, we also deviated from the classical DRM paradigm in which we kept the word lists and translated them to Castellano, but added contextual details in the form of different figures and colors accompanying the words. This was based on Woods and Riesthuis (2016), who explored whether monolingual Americans would add contextual details to a false memory. They sought to shed light on the topic following Lyle and Johnsons (2006), who discovered that when participants added and specified contextual details in memories, it seemed to increase their confidence in their recalled memory.

Our interest was to what extent the monolingual and bilingual groups would differ in adding contextual details to a falsely recalled critical lure. This means that the participants were exposed to DRM lists, and with each word, a figure with color was also presented. The participants were instructed to, if possible, recall the word with the two contextual details. Of interest was whether there was a difference between monolinguals' and bilinguals' performance in the false recall, as well as whether they added any contextual details to this false recall. This would indicate increased confidence in the false memory. Our expectation was that due to the greater predicted associated semantic network in bilinguals compared to monolinguals, the bilinguals would have a higher recall rate of false memory with contextual details. This goes hand in hand with the assumption that the greater associated semantic network would increase false memory on its own.

Method

Participants

There were 42 participants aged 18 to 30 years, among whom 24 were male (M_{age} = 21.4, SD = 2.85). The database of the Center of Brain and

Cognition from Pompeu Fabra University was used for recruitment. The participants were recruited for two groups on the basis of whether they were bilingual in Spanish and Catalan, with Spanish dominance, or monolingual in Spanish. It is important to note that Pompeu Fabra University has three official languages. This means that the participants were capable of speaking English at a B2 level of proficiency based on the Common European Framework of Reference for Languages. The participants in both groups had this proficiency level. Therefore, our requirements for the bilingual group were that they were fluent in both languages, with Spanish being dominant. The requirements for the monolingual group were that they were fluent in Spanish and had no exposure to Catalan. To avoid this exposure, the recruited monolingual participants were of South American and Spanish origin (N = 13) and Spanish (N = 8) origin. Additional requirements for Spanish participants were that their origin was outside the autonomous Catalonian region and that they had no previous exposure to Catalan. Both the bilingual and monolingual groups had 21 participants. The participants gained monetary compensation for their participation in the study.

Stimuli

The materials were eight DRM lists containing 12 words each (see Appendix). The word lists were directly translated from English to Spanish. Due to translations issues, we reduced the word lists from 15 words to 12 words as the translations of some words would include the critical lure (e.g., *window* (*ventana*), *shutter* = *contraventana*, in which *ventana* would be the critical lure, as further clarified in the Appendix). Along with these differences in DRM lists, the lists also differed from classical DRM lists, which contain only words, in that they had accompanying figures and colors that had to be recalled as well (see Figure 1). The same figures and colors were utilized in all eight lists (see Appendix), although they were randomized throughout the lists to prevent the participants from detecting an order. The words were presented for 250 ms with an interstimulus delay of 32 ms, following the standard timeframe of McDermott and Watson (2001). The words were presented visually, in Calibri (body) font size 44, through Microsoft PowerPoint 2015.

Procedure

The participants were invited to the laboratory of the Center for Brain and Cognition at Pompeu Fabra University. Upon arrival, the participants were asked to view several word lists and then to write down what they remembered. The words were presented in the center of the screen with a surrounding and centered figure that was outlined in color. After the DRM word lists were shown, the participants had unlimited time to recall what they remembered. Every participant completed the study within 15 minutes. The instructions for the experiment were, "You are going to see several word lists. Words will be shown one by one, accompanied by a figure and color. After every word list, you will have to write down what you remember of the word list on the recall booklet in front of you. Write down the words and the accompanying figure and color, if possible. If you only remember one or two of the three requested items, you can write just those. Only write down what you remember for certain. Otherwise, you can write, 'Don't remember.' Your recall of the words doesn't have to be in the order in which the words were presented." The participants were asked not to write during the presentation of the words. Upon completion of the experiment, they were debriefed about the aim of the study.

Figure 1. ***Example of stimuli***

Results

True Recall

An item recalled by the participant that was in accordance with the word list was considered a true recall. This was accepted without the corresponding figure or color, as will be discussed in the following section. To determine whether there was a statistically significant difference between the bilingual Spanish-Catalan group and the monolingual Spanish group in terms of true recall performance, we used a one-way analysis of variance (ANOVA). The results showed a statistically significant effect, namely, that bilinguals had a higher true recall rate compared to monolinguals, F (1, 40) = 4.49, p = 0.04, η2 = 0.33 (see Figure 2 and Table 1).

True Recall and Contextual Details

An item recalled by the participant that was in accordance with the word list and with its correct accompanying figure and color was considered a true recall with contextual details. To determine whether there was a statistically significant difference in true recall and contextual details between the bilingual Spanish-Catalan group and the monolingual Spanish group, we used a one-way ANOVA. No statistically significant effect was found, F (1, 40) = 0, p = 0.97, η2 = 0.01.

False Recall

An item recalled by the participant that was the critical lure of the DRM list was considered a false recall. Any other word that was not on the DRM list was not considered false recall but, rather, an intrusion. This was accepted without a figure or color recalled, as will be discussed in the following section. To determine whether there was a significant difference between the bilingual Spanish-Catalan group and the monolingual Spanish group, we used a one-way ANOVA. No statistically significant effect was observed, F (1, 40) = 1.34, p = 0.25, η2 = 0.18.

Figure 2. ***True recall rates for the bilingual and monolingual group (Error bars stand for 95% confidence interval for the mean).***

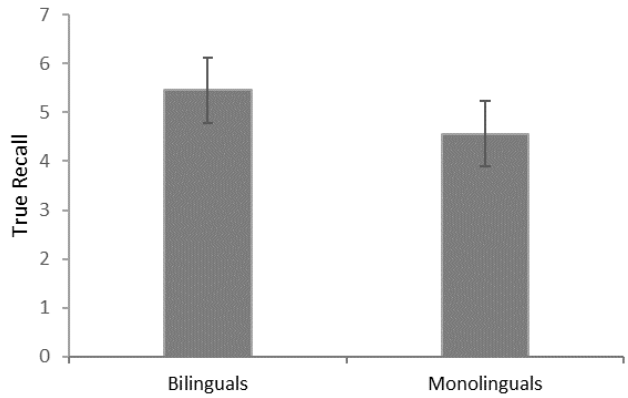

Table 1. ***Means and standard deviations of areas of interest. Only significant difference in true recall between bilinguals and monolinguals***

	Bilinguals		Monolinguals	
	Mean	*SD*	*Mean*	*SD*
True Recall	5.45	1.26	4.57	1.45
True Recall with Contextual Details	0.98	1.12	0.97	0.61
False Recall	0.20	0.16	0.14	0.17
False Recall with Contextual Details	0.036	0.070	0.024	0.075

False Recall with Contextual Details

An item recalled by the participant that was the critical lure of the DRM list accompanied by a figure and color was considered a false recall with contextual details. This was only accepted when the figure and color were falsely recalled. To determine whether there was a significant difference between the bilingual Spanish-Catalan group and the monolingual Spanish group, we used a one-way ANOVA. No statistically significant effect was detected, F (1, 40) = 0.28, p = 0.59, η2 = 0.084.

Discussion

In this study, we examined whether there was a difference between Spanish-Catalan bilinguals and Spanish monolinguals in false memory production. We also aimed to clarify whether there would be a difference in the adding of contextual details to a false memory, which would indicate an increased level of confidence (Lyle & Johnson, 2006). Previous research (Woods & Riesthuis, 2016) indicated that contextual details are remembered when they are introduced into the DRM paradigm. However, the previous research did not investigate whether these contex-

tual details differed between bilinguals and monolinguals.

We found a difference between bilinguals and monolinguals in true memory. Specifically, bilinguals had a higher recall rate for correct items than their monolingual counterparts did. This result is, to a certain extent, in line with the results of Marmolejo et al. (2009), which showed that Spanish-English bilinguals had a higher true recall rate in their dominant language compared to their non-dominant language. To our knowledge, the results of this study are the first to demonstrate a clear difference between bilinguals and monolinguals in true recall performance.

One explanation for this result was offered by Kaushanskaya, Blumenfeld, and Marian (2011), who described that bilinguals rely more on short-term memory resources for word retrieval than monolinguals do. The DRM task relies to a certain extent on short-term memory, and this could lead to the observed difference in the current study on true recall, as bilinguals have a higher reliance on short-term memory for word retrieval. Another explanation, which needs further research, might be that bilinguals have two vocabularies for both languages, with great similarities in both gist and verbatim information. Having to store twice the lexical items would increase the memory demands and allow them to remember the words better.

The main aim of the study was to assess whether there would be a difference in false memory between bilinguals and monolinguals. We found no statistical difference in false memory susceptibility between the two groups. Anastasi et al. (2005) showed that bilinguals had higher false recognition rates when tested in their non-dominant language compared to their dominant language. However, when compared to monolinguals of that same language, the differences faded. The current study yielded similar results as no differences were observed. Our expectation was that bilinguals would have a higher rate of false recall due to the gist and verbatim similarities between languages and the higher rate of true recall, but this expectation was not borne out in the data.

Another aim of the study was to understand whether bilinguals are more inclined to add contextual details to a false memory. Notably, both bilinguals and monolinguals added contextual details to a false memory. This indicates that, even though the participants were instructed to write down only what they remembered and that it was acceptable to leave a blank space, they were still inclined and willing to commit to contextual details. According to Lyle and Johnson (2006), this adding of details indicates increased confidence in the false memory. The finding is interesting in itself and should be investigated further. Regarding the current study, the results showed that there were no significant differences between bilinguals and monolinguals in the adding of contextual details with a false memory.

Our results thus indicate a sole difference of higher correct recall in bilinguals compared to monolinguals. This is of importance for growing urban areas, which goes hand in hand with a larger number of bilingual residents (Bialystok, Craik, & Luk, 2012). It is interesting to understand how memory might differ in bilinguals in a world that is increasingly urbanizing, which means bilinguals are growing in number. Our results thus show that bilinguals are more reliable in correct recall, though no differences were found in the false recall. This finding could have a positive impact on urbanizing societies, as false memory formation is not affected while correct memory seems to be enhanced. However, further research on false and correct memory by monolinguals and bilinguals is necessary.

The interest of contextual details was partly for understanding confidence in a false memory, but also for understanding whether verbatim information is included in false memory. An interesting finding was that participants in both groups were willing to commit to contextual details with a falsely recalled item. The FTT argues that false memories are formed solely through gist information, but our study shows that unrelated contextual details are still added. However, the amount of recalled contextual details was low and should be examined further to make compelling claims as to what extent they are involved in false memory formation. An interesting project would be to examine whether false memory formation would increase or decrease with the addition of contextual details and to what extent these details are recalled alongside the false memory. This can help clarify whether contextual details actually aid false memory formation or disrupt it.

Conclusions

We found that when comparing monolinguals' and bilinguals' performance in false memory creation, only a difference in true memory was detected. Further research is necessary to understand to what extent false and true memories are encoded and processed similarly in mono- and bilinguals.

Declaration of Conflicting Interest

The authors declared that there were no conflicts of interest with respect to the authorship or the publication of this article.

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References

Altarriba, J. (2003). Does carino equal "liking"? A theoretical approach to conceptual nonequivalence between languages. International Journal of Bilingualism, 7(3), 305-322. https:/ doi.org/10.1177/13670069030070030501

Anastasi, J., Rhodes, M., Marquez, S., & Velino, V. (2005). The incidence of false memories in native and non-native speakers. Memory, 13 (8), 815-828. https://doi.org/10.1080/09658210444000421

Arndt, J. (2010). The role of memory activation in creating false memories of encoding context. Journal of Experimental Psychology: Learning, Memory, and Cognition, 36(1), 66-79. http://dx.doi.org/1 0.1037/a0017394

Bialystok, E., Craik, F. I., & Luk, G. (2012). Bilingualism: consequences for mind and brain. Trends in cognitive sciences, 16(4), 240-50. https://doi.org/10.1016 j.tics.2012.03.001

Brainerd, C., & Reyna, V. (2002). Fuzzy-Trace theory and false memory. Current Directions in Psychological Science, 11(5), 164-169. https://doi.org/10.1111/1467-8721.00192

Brainerd, C. J., Reyna, V. F., & Ceci, S. J. (2008). Developmental reversals in false memory: A review of data and theory. Psychological Bulletin, 134(3), 343-382. http://dx.doi.org/10.1037/0033-2909.134.3.343

Howe, M. L., Gagnon, N. & Thouas, L. (2008). Development of false memories in bilingual children and adults. Journal of Memory and Language, 58(3), 669-681. https://doi.org/10.1016/j.jml.2007.09.001

Howe, M. L., Wimmer, M. C., Gagnon, N. & Plumpton, S. (2009). An associative activation theory of children's and adults' memory illusions. Journal of Memory and Language, 60(2), 229-251. https://doi.org/10.1016/j.jml.2008.10.002

Gallo, D. A., McDermott, K. B., Percer, J. M., & Roediger,H. L., III. (2001). Modality effects in false recall and false recognition. Journal of Experimental Psychology: Learning, Memory, & Cognition, 27(2), 339-353. http://dx.doi.org/10.1037/0278-7393.27.2.339

García-Bajos, E., & Migueles, M. (1997). Falsas memorias en el recuerdo y reconocimiento de Palabras. [False memories in the recall and recognition of words]. Estudios de Psicología, 18(58), 3-13. https://doi.org/10.1174/021093997320954818

Grosjean, F. (2008). *Studying Bilinguals*. New York. Oxford University Press.

Kaushanskaya, M., Blumenfeld, H. K., & Marian, V. (2011). The relationship between vocabulary and short-term memory measures in monolingual and bilingual speakers. International Journal of Bilingualism, 15(4), 408-425. https://doi.org/10.1177/1367006911403201

Kawasaki-Miyaji, Y., Inoue, T., & Yama, H. (2003). Cross-Linguistic False Recognition: How Do Japanese-Dominant Bilinguals Process Two Languages: Japanese And English? Psychologia - An International Journal of Psychology in the Orient, 46(4), 255-267. https://doi.org/10.2117/psysoc.2003.255

Lindsay, D., & Read, J. (1995). "Memory work" and recovered memories of childhood sexual abuse: Scientific evidence and public, professional, and personal issues. Psychology, Public Policy, and Law, 1(4), 846-908.

http://dx.doi.org/10.103 7/1076-8971.1.4.846

Lyle, K., & Johnson, M. (2006). Importing perceived features into false memories. Memory, 14(2), 197-213. https://doi.org/10.1080/09658210544000060

Marmolejo, G., Diliberto-Macaluso, K. A., & Altarriba, J. (2009). False Memory in bilinguals: Does switching languages increase false memories? *American Journal of Psychology, 122*(1), 1-16. Retrieved from https://www.jstor.org/stable/27784371

McDermott, K., & Watson, J. (2001). The rise and fall of false recall: The impact of presentation duration. Journal of Memory and Language, 45(1), 160–176. https://doi. org/10.1006/jmla.2000.2771

Pérez-Mata, M. N., Read, J. D., & Diges, M. (2002). Effects of divided attention and word concreteness on correct recall and false memory reports. Memory, 10(3), 161-177. https://doi.org/10.1080/09658210143000308

Roediger, H. L., & Mcdermott, K. (1995). Creating false memories: Remembering words not presented in lists. Journal of Experimental Psychology: Learning, Memory, and Cognition, 21(4), 803-814. https://doi.org/10.1037/0278-7393.21.4.803

Roediger, H. L., Watson, J. M., McDermott K., Gallo, D. A. (2001). Factors that determine false recall: A multiple regression analysis. Psychonomic Bulletin & Review, 8(3), 385–407. https://doi.org/10.3758/BF03196177

Sahlin, B. H., Harding, M. G., & Seamon, J. G. (2005). When do false memories cross language boundaries in English—Spanish bilinguals? *Memory & Cognition, 33*(8), 1414-1421. Retrieved from https://link.springer.com/article/10.3758/BF03193374

Stein, L. M., & Pergher, G. K. (2001). Criando falsas memorias em adultos por meio de palabras associadas [Creating false memories in adults using associated word lists]. *Psicologia: Reflexão e Crítica, 14*(2), 353-366. http://dx.doi.org/10.1590/S0102-79722001000200010

Thierry, G., & Wu, Y. J. (2007). Brain potentials reveal unconscious translation during foreign-language comprehension. *Proceedings of the National Academy of Sciences, 104*, 12530-12535. https://doi.org/ 10.1073/pnas.0609927104

Woods, J., Riesthuis, P. (2016). *Context information for words that were never presented*. Des Moines, IA, The United States. Grand View University.

68% of the world population projected to live in urban areas by 2050, says UN | UN DESA Department of Economic and Social Affairs. (2018). Retrieved from https://www.un.org/development/desa/en/news/population/2018-revision-of-world urbanization-prospects.html

Appendix

Deese-Roediger-McDermott Lists				
	List 1	**List 2**	**List 3**	**List 4**
Critical Lure	**Doctor**	**Ventana**	**Frío**	**Humo**
Words	Enfermera	Puerta	Caliente	Cigarro
	Mareado	Vidrio	Nieve	Contaminación
	Medicina	Sombra	Invierno	Cenizas
	Salud	Alféizar	Húmedo	Puro
	Hospital	Casa	Glacial	Chimenea
	Dentista	Abierto	Helado	Fuego
	Físico	Cortina	Calor	Tabaco
	Enfermo	Marco	Temperatura	Peste
	Paciente	Paisaje	Congelar	Pipa
	Estetoscopio	Brisa	Tiritar	Pulmones
	Cirujano	Pantalla	Polar	Llamas
	Clínica	Persiana	Escarcha	Mancha
	List 5	**List 6**	**List 7**	**List 8**
Critical Lure	**Música**	**Río**	**Olor**	**Suave**
Words	Nota	Agua	Nariz	Duro
	Sonido	Lago	Respirar	Ligero
	Piano	Llobregat	Oler	Cojín
	Cantar	Bote	Aroma	Afelpado
	Radio	Marea	Oír	Ruidoso
	Melodía	Nadar	Ver	Algodón
	Concierto	Fluir	Apestar	Tocar
	Instrumento	Correr	Hedor	Pluma
	Sinfonía	Lancha	Fragancia	Peludo
	Orquestra	Pez	Perfume	Gatito
	Arte	Puente	Sales	Piel
	Ritmo	Sinuoso	Rosa	Blando

Appendix

Figures and Colors accompanied with the DRM word Lists

Figures	Colors
Triangle	Red
Circle	Light Green
Square	Black
Cross	Dark Green
Star	Gray
Column	Purple
Heart	Dark Blue
Rectangle	Yellow
Box	Light Blue
Diamond	Orange
Two Arrows (Pointing left and right)	Pink
One arrow (Pointing right)	Brown

Note. The figures and colors were randomized with every DRM list to prevent participants from perceiving a pattern.