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BRAIN ELECTRICAL SIGNATURES OF THE NOVEL WORD LEXICALIZATION

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Abstract

There is currently an increasing interest in the acquisition of reading fluency. This is characterized as automated reading with higher rates of speed and accuracy that enables the reader to carry out processes of higher-level comprehension. A key factor in reading fluency is the establishment of word representations in the reader's lexicon, which allow the direct visual recognition of words. It is widely accepted that a repeated visual exposure to novel words is needed to construct these mental representations. However, the nature of memory traces reached after this training is a question hotly debated in behavioral literature. While some authors argue that a simple visual training enables the formation of lexical traces for novel words, others argue that a training not only in orthographic but also in other word features (such as phonology or meaning) is required for the acquisition of high quality lexical representations. The use of more suitable measures for exploring the brain response during this process could contribute to solve this question. In this sense, the ERP approach emerges as a powerful tool to study the neurophysiological mechanisms underlying the acquisition of the lexical reading, and particularly the training conditions under which the formation of high quality lexical representations is possible. In this paper, the main contributions from the ERP literature to the understanding of the novel word lexicalization are reviewed.

Keywords: reading, novel word lexicalization, ERP methodology, N400, LPC.

Reading fluency and representation of words in a lexicon

Reading fluency is characterized as the ability to read words quickly and accurately. Contrary to non-fluent reading, this automatic reading does not require a serial, letter-by-letter decoding, as word letters are recognized in parallel (Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001; Meyer & Felton, 1999). Therefore, it allows the reader to carry out higher-level cognitive processes, such as establishing meaningful connections between words, making inferences and, importantly, understanding the text that is being read. How readers reach this

direct visual recognition of words and especially the nature of processes involved are questions still under debate.

It is generally accepted that a repeated visual experience with words leads to the automatization of reading (Ehri & Wilce, 1983; Perfetti, 1985; Share, 1995). Following the dual-route reading model (Coltheart et al., 2001), the more the word is exposed, the more information is stored in the reader's orthographic lexicon, which results in the decrease of the word activation threshold. Thus, visual repetition allows the formation of mental representations from which sublexical reading (that is slow and inaccurate as entails a serial grapheme-phoneme decoding), evolves to a lexical reading in which words are recognized directly. In this sense, the acquisition of grapheme-phoneme correspondences becomes crucial during this process. According to Share (Share, 1995), the achievement of phonological processes constitutes a sine qua non condition to construct orthographic representations of words. Thus, each successful decoding is a self-teaching opportunity to extract orthographic information which contributes to word lexicalization.

Therefore, the formation of new orthographic representations is considered a key factor in the acquisition of reading fluency. Different behavioral studies have demonstrated that orthographic traces can be achieved in a relatively fast process, after few visual presentations of a novel word (Bowers, Davis, & Hanley, 2005; Kwok, Cuetos, Avdyli, & Ellis, 2017; Kwok & Ellis, 2015; Leach & Samuel, 2007; Maloney, Risko, O'Malley, & Besner, 2009; Qiao, Forster, & Witzel, 2009; Qiao & Forster, 2013; Suárez-Coalla, Álvarez-Cañizo, & Cuetos, 2016; Tamura, Castles, & Nation, 2017). In these studies, reductions in the length effect showed by trained words or interference in the access of familiar words already established into the reader's lexicon are taken as an index of the novel word lexicalization. However, there is no agreement concerning the nature of the orthographic representations obtained after visual exposure. Some of these studies have claimed that the nature of these traces is episodic rather than lexical, as no lexical competition effect is observed after visual training ensuring a similar processing level between trained and familiar words. As a counterbalance, it is argued that a multimodal rather than a simple visual training of novel words could trigger a more interactive and efficient reading by the establishment of connections between different processing levels —orthographic, semantic or phonological — and therefore result in a better strategy for the complete lexicalization of novel words (Breitenstein et al., 2007; Clay, Bowers, Davis, & Hanley, 2007; Leach & Samuel, 2007; Qiao et al., 2009; Qiao & Forster, 2013). In fact, the lexical quality hypothesis states that acquisition and integration of word information at different levels is the key factor for the achievement of high-quality mental representations that can be accessed directly (Perfetti & Hart, 2002).

In sum, even though it is assumed that visual experience with words is necessary for the acquisition of reading fluency, this training may be not enough to accomplish the complete lexicalization of words. Despite findings obtained, behavioral approaches cannot account for the advantage of a combined training over a simple visual exposure in terms of the lexical nature of representations. In this regard, neurophysiological approaches have demonstrated to be more useful for this purpose.

The use of ERP measures in the study of word lexicalization

Studies of reading and novel word lexicalization have been traditionally carried out by taking behavioral data as a dependent variable. However, this account is not suitable for solving important questions concerning lexicalization of novel words, namely what are the neurophysiological mechanisms involved in the formation of novel word traces and what is the nature of traces built-up under different training procedures. Therefore, the use of fine-grain techniques has extensively increased in order to track modulations in reading processing in a more accurate way.

In this sense, the recording of event-related potentials is an excellent approach to obtain online variations in reading processing. In brief, this technique allows the measurement (in terms of milliseconds) of fluctuations in brain electrical activity as a consequence of stimulus presentation considered to reflect the underlying cognitive processing (Picton & Hillyard, 1988). This higher temporal resolution has a critical advantage over behavioral or even neuroimaging techniques. These techniques measure changes that are subsequent to neuronal depolarization, providing information that is posterior to the cognitive processing of interest and therefore not suitable to investigate changes during the lexicalization of novel words. Contrary, the ERP approach enables the continuous measure of activity changes occurred in the reader's cognitive system providing precise information about the time course and the order of different cognitive processes involved during novel word reading.

Therefore, using an ERP approach is an excellent option to study changes that occurred during the cognitive processing by readers as consequence of novel word training. However, it must be noted this technique does not provide information about brain areas from which these changes emerge, only about the scalp topography where voltage changes are recorded. Since multiple neural source configurations could be responsible for the electrical activity distribution that is registered in the scalp, the intracerebral generators of this activity cannot be unequivocally determined. This is known as the inverse problem and is the main disadvantage of this technique. Nonetheless, several inverse solution methods based on algorithms have been successfully developed to solve this issue (Michel et al., 2004).

Main ERP findings of new word lexicalization

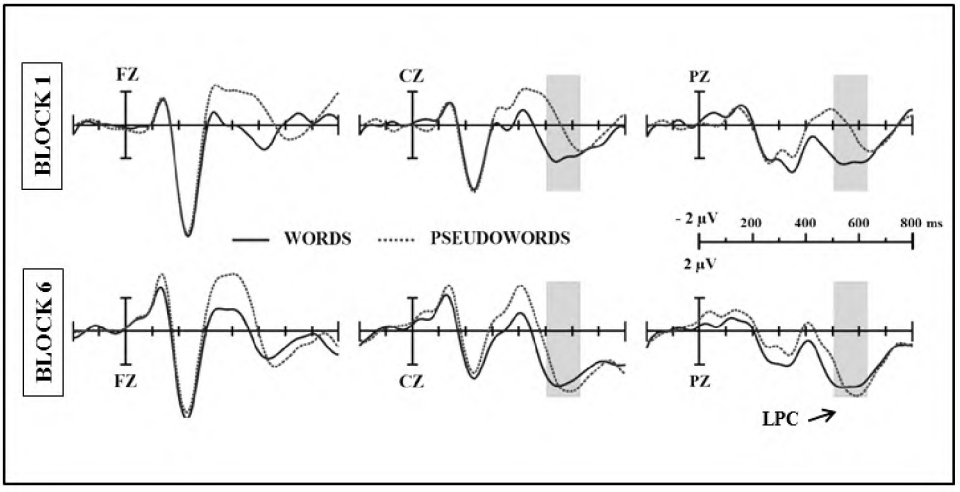
Contrary to behavioral literature, there are very few ERP studies addressed to account for the effects of simple visual training of novel words. In fact, there is only one study reporting the either online brain activity modulation occurring during the visual training of novel stimuli (Bermúdez-Margaretto, Beltrán, Domínguez, & Cuetos, 2015). In this work, pseudowords repeatedly presented in a lexical decision task showed a significant increase in the LPC amplitude, until the lexicality effect was found eliminated in this component after six repetitions. No other ERP components were found modulated as a consequence of visual training (see Figure 1). The LPC component is characterized as a positive wave which emerges around 500 to 700 ms after stimulus onset in centro-posterior scalp distributions. It has been tra-

ditionally related to episodic memory processes and conscious recollection of previously presented information (Rugg & Curran, 2007). In this sense, LPC enhancements found after stimuli repetition have been considered to reflect a recollection process of episodic information from long-term memory. Interestingly, results found in this study point out that repeated visual exposure to pseudowords allows the formation of episodic memory traces which leads to the more efficient reading and categorization of these stimuli through the task. Therefore, this study supports the idea that visual exposure is not enough for the acquisition of lexical-quality representations suggesting that novel word training should involve not only visual but other information levels from which to develop a more interactive processing that enables a complete novel word lexicalization.

Apart from this visual training study, the majority of ERP studies exploring the process of novel word lexicalization have been focused on electrophysiological changes occurred as a consequence of the combination of both visual and semantic training. In these studies, novel words are provided with a concept by repeated associations to pictures (Dobel et al., 2009) or definitions (Bakker, Takashima, van Hell, Janzen, & McQueen, 2015; Perfetti, Wlotko, & Hart, 2005) or embedding them in meaningful sentence contexts (Batterink & Neville, 2011; Borovsky, Elman, & Kutas, 2012; Borovsky, Kutas, & Elman, 2010; Frishkoff, Perfetti, &

Figure 1

Averaged ERP waveforms at medial scalp sites for words and pseudowords presented at the first and the sixth repetition blocks (adapted from Bermúdez-Margaretto et al., 2015)



Note. Grey shaded areas highlight the time window of the significant interaction between stimuli and block type. LPC amplitude for pseudowords increased across visual repetitions, which contributed to the absence of the lexicality effect in the last experimental block. These results reflect the formation and strengthening of memory episodic traces, which led to improve the recognition and lexical decision for repeated pseudowords across the task.

Collins-Thompson, 2010; Mestres-Missé, Rodriguez-Fornells, & Münte, 2007). LPC enhancements are also reported in some of these studies considered to reflect the codification and strengthening of episodic memory traces for novel words as a consequence of repetitions, which facilitate their recognition in later encounters (Bakker et al., 2015; Batterink & Neville, 2011; Perfetti et al., 2005). However, the main finding is that meaningful associations might transfer semantic content to trained stimuli leading to reductions in the amplitude of the N400 component. This is a negative wave with the maximum amplitude emerging around 400 ms after a stimulus presentation at posterior scalp configurations. It is one of the most-well studied components in relation to language processing and it has been traditionally associated with semantic processing (Kutas & Federmeier, 2011). Since non-frequent, meaningless or context-incongruent stimuli show higher N400 amplitudes, this component is taken as a marker of the effort in access to the lexico-semantic processing of the stimuli. In this sense, reduced N400 amplitudes found after the semantic training have been considered an index of the meaning acquisition and integration of novel stimuli into the reader's lexico-semantic system.

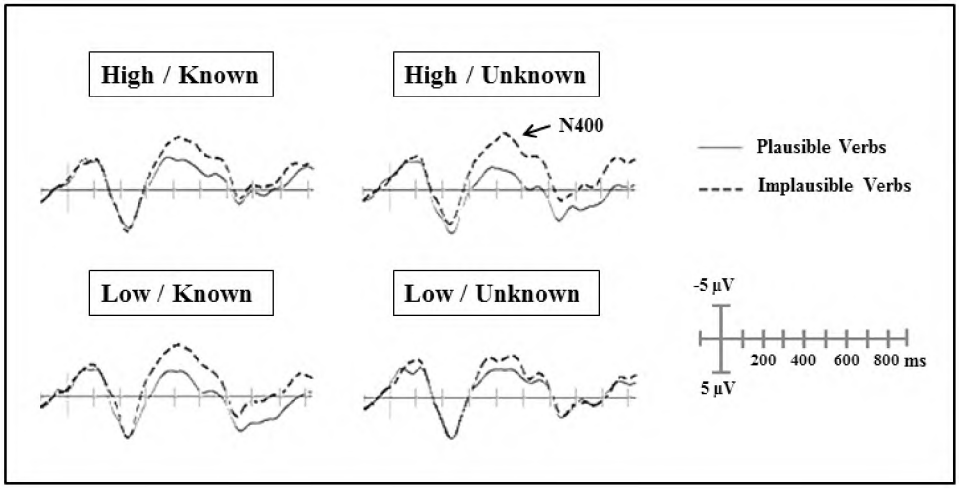
Some of these studies argue that an intensive and long-lasting training of novel words is required to achieve lexico-semantic representations (McLaughlin, Osterhout, & Kim, 2004; Stein et al., 2006). For instance, one of these studies found that after 14 hours of French training, English-native participants showed a N400 lexicality effect when they were confronted with French pseudowords in a lexical decision task. Additionally, reduced N400 amplitudes were generated by French words preceded by another semantically related French word, although this priming effect was found after 63 hours of training (McLaughlin et al., 2004). These results reflect that visual and semantic training in novel words allows the acquisition of a lexical status for trained stimuli although their semantic integration seems to occur only after an extensive period of training. Other studies have remarked not only on the importance of a relatively high number of exposures but also the presence of consolidation periods between training sessions (Bakker et al., 2015).

However, several rapid word learning studies have reported N400 effects reflecting the acquisition of lexico-semantic properties for novel words after a short training period, even in a single-day session involving just a few expositions (Batterink & Neville, 2011; Dobel et al., 2009; Frishkoff et al., 2010; Mestres-Missé et al., 2007; Perfetti et al., 2005). In fact, some authors have reported effects that indicate the integration of novel stimuli into the reader's processing system after a single meaningful exposure (Borovsky et al., 2012; Borovsky et al., 2010). Thus, Borovsky et al. reported a plausibility effect in the N400 component for those verbs preceding a novel word previously presented in a highly constrained sentence (see Figure 2). This study shows that a single but strongly constrained exposure is enough to integrate a mental representation into the lexical and grammatical systems of readers from which to access word usage knowledge.

Taking into account these findings, two critical statements can be highlighted. On the one hand, the formation of mental representations to achieve an adequate reading fluency is possible after a brief visual training in novel words. However, the

Figure 2

Averaged ERP waveforms (right medial central electrode) for Plausible or Implausible Verbs preceding Known or Unknown targets previously presented under High or Low constrained sentences (adapted from Borovsky et al., 2010)



Note. A plausibility effect was found in the N400 component in all conditions except for verbs preceding unknown words presented in low constrained contexts. These results suggest that after a single exposure in a strongly constrained context is possible to acquire lexical and grammatical traces from which judge the novel word usage.

nature of these mental representations seems to be episodic, instead of lexical, as is indicated by LPC enhancements observed through visual exposures of novel words. On the other hand, a combination of both visual and semantic exposures to novel words is postulated as the key factor for the acquisition of a complete lexicalization. In this sense, N400 reductions found after this combined training reflect the integration of these stimuli in the reader's lexico-semantic system. Furthermore, this process might be developed relatively fast, as several studies have confirmed.

Conclusion and future considerations

The use of the ERP approach for examining change in the brain electrical activity as a consequence of training novel words has provided valuable information. In this sense, not only the processes involved in the achievement of mental representations but also, and importantly, the nature of representations achieved after a visual or a combined training has been clarified. However, some aspects must be considered for future research in rapid word learning.

On the one hand, there is only one ERP study exploring the effect of the simple visual training in novel word lexicalization (Bermúdez-Margaretto et al., 2015). Moreover, it must be noted that the formation of episodic memory traces found

through this lexical decision task could be a consequence of the recollection of the previously presented information in order to carry out the lexical categorization of the stimuli. Therefore, results found in this study must be cautiously considered. In other studies, the effect of training novel words under meaningful contexts is compared to the absence of training (Dobel et al., 2009; Perfetti et al., 2005) or to the effect of training under low-constrained semantic contexts (Batterink & Neville, 2011; Borovsky et al., 2010; Frishkoff et al., 2010; Mestres-Missé et al., 2007). Therefore, more ERP studies evaluating the effect of a simple visual training of new words as well as comparing the effects of visual and semantic training are needed. This comparison could directly inform about the nature of traces built-up under each training, which is a promising line for future research on the novel word lexicalization.

On the other hand, the observation of semantic priming effects (Borovsky et al., 2010; Frishkoff et al., 2010; Perfetti et al., 2005) or lexicality effects (Batterink & Neville, 2011; Mestres-Missé et al., 2007) in the N400 component after semantic training is usually taken in these studies as an index of the integration of a novel word into lexico-semantic systems of readers. However, none of these ERP studies have considered change in the prime lexicality effect as a marker for novel word lexicalization. This is a more precise measure to examine the lexicalization of novel words since it evaluates the lexical competition between trained stimuli and those well-established in the reader's lexicon.

Finally, the influence of previous experience in the lexicalization of words should be further examined, since very few ERP studies have addressed this question (Balass, Nelson, & Perfetti, 2010). In this sense, it would be worthwhile to track changes in the ERP signal during visual training of novel words for which information at other processing levels has already been acquired. Particularly, the use of lexical competition measures to determine which type of prior knowledge — phonologic, semantic or both — leads to a greater advantage in the lexicalization of words, should be also considered in future research.

References

Bakker, I., Takashima, A., van Hell, J. G., Janzen, G., & McQueen, J. M. (2015). Tracking lexical consolidation with ERPs: Lexical and semantic-priming effects on N400 and LPC responses to newly-learned words. *Neuropsychologia, 79*, 33–41.

Balass, M., Nelson, J. R., & Perfetti, C. A. (2010). Word learning: An ERP investigation of word experience effects on recognition and word processing. *Contemporary Educational Psychology, 35*(2), 126–140.

Batterink, L., & Neville, H. (2011). Implicit and explicit mechanisms of word learning in a narrative context: An event-related potential study. *Journal of Cognitive Neuroscience, 23*(11), 3181–3196. doi:10.1162/jocn_a_00013

Bermúdez-Margaretto, B., Beltrán, D., Domínguez, A., & Cuetos, F. (2015). Repeated exposure to "meaningless" pseudowords modulates LPC, but not N (FN) 400. *Brain Topography, 28*(6), 838–851.

Borovsky, A., Elman, J. L., & Kutas, M. (2012). Once is enough: N400 indexes semantic integration of novel word meanings from a single exposure in context. *Language Learning and Development, 8*(3), 278–302.

Borovsky, A., Kutas, M., & Elman, J. (2010). Learning to use words: Event-related potentials index single-shot contextual word learning. *Cognition, 116*(2), 289–296.

Bowers, J. S., Davis, C. J., & Hanley, D. A. (2005). Interfering neighbours: The impact of novel word learning on the identification of visually similar words. *Cognition, 97*(3), B45–B54.

Breitenstein, C., Zwitserlood, P., de Vries, M. H., Feldhues, C., Knecht, S., & Dobel, C. (2007). Five days versus a lifetime: Intense associative vocabulary training generates lexically integrated words. *Restorative Neurology and Neuroscience, 25*(5, 6), 493–500.

Clay, F., Bowers, J. S., Davis, C. J., & Hanley, D. A. (2007). Teaching adults new words: the role of practice and consolidation. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 33*(5), 970.

Coltheart, M., Rastle, K., Perry, C., Langdon, R., & Ziegler, J. (2001). DRC: a dual route cascaded model of visual word recognition and reading aloud. *Psychological Review, 108*(1), 204.

Dobel, C., Junghöfer, M., Breitenstein, C., Klauke, B., Knecht, S., Pantev, C., & Zwitserlood, P. (2009). New names for known things: On the association of novel word forms with existing semantic information. *Journal of Cognitive Neuroscience, 22*(6), 1251–1261. doi:10.1162/jocn.2009.21297

Ehri, L. C., & Wilce, L. S. (1983). Development of word identification speed in skilled and less skilled beginning readers. *Journal of Educational Psychology, 75*(1), 3.

Frishkoff, G. A., Perfetti, C. A., & Collins-Thompson, K. (2010). Lexical quality in the brain: ERP evidence for robust word learning from context. *Developmental Neuropsychology, 35*(4), 376–403. doi:10.1080/87565641.2010.480915

Kutas, M., & Federmeier, K. D. (2011). Thirty years and counting: Finding meaning in the N400 component of the event related brain potential (ERP). *Annual Review of Psychology, 62*, 621–647. doi:10.1146/annurev.psych.093008.131123

Kwok, R. K. W., Cuetos, F., Avdyli, R., & Ellis, A. W. (2017). Reading and lexicalization in opaque and transparent orthographies: Word naming and word learning in English and Spanish. *The Quarterly Journal of Experimental Psychology, 70*(10), 2105–2129.

Kwok, R. K. W., & Ellis, A. W. (2015). Visual word learning in skilled readers of English. *The Quarterly Journal of Experimental Psychology, 68*(2), 326–349.

Leach, L., & Samuel, A. G. (2007). Lexical configuration and lexical engagement: When adults learn new words. *Cognitive Psychology, 55*(4), 306–353.

Maloney, E., Risko, E. F., O'Malley, S., & Besner, D. (2009). Tracking the transition from sublexical to lexical processing: On the creation of orthographic and phonological lexical representations. *The Quarterly Journal of Experimental Psychology, 62*(5), 858–867. doi:10.1080/17470210802578385

McLaughlin, J., Osterhout, L., & Kim, A. (2004). Neural correlates of second-language word learning: Minimal instruction produces rapid change. *Nature Neuroscience, 7*(7), 703–704.

Mestres-Missé, A., Rodriguez-Fornells, A., & Münte, T. F. (2007). Watching the brain during meaning acquisition. *Cerebral Cortex, 17*(8), 1858–1866.

Meyer, M. S., & Felton, R. H. (1999). Repeated reading to enhance fluency: Old approaches and new directions. *Annals of Dyslexia, 49*, 283–306.

Michel, C. M., Murray, M. M., Lantz, G., Gonzalez, S., Spinelli, L., & de Peralta, R. G. (2004). EEG source imaging. *Clinical Neurophysiology, 115*(10), 2195–2222.

Perfetti, C. A. (1985). *Reading ability*. New York: Oxford University Press.

Perfetti, C. A., & Hart, L. (2002). The lexical quality hypothesis. *Precursors of Functional Literacy, 11*, 67–86.

Perfetti, C. A., Wlotko, E. W., & Hart, L. A. (2005). Word learning and individual differences in word learning reflected in event-related potentials. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 31*(6), 1281–1292. doi:10.1037/0278-7393.31.6.1281

Picton, T., & Hillyard, S. (1988). Endogenous component of the event-related brain potential. In T. Picton (Ed.), *Human event-related potentials: EEG handbook* (pp. 361–426). Amsterdam: Elsevier.

Qiao, X., & Forster, K. I. (2013). Novel word lexicalization and the prime lexicality effect. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 39*(4), 1064.

Qiao, X., Forster, K., & Witzel, N. (2009). Is banara really a word? *Cognition, 113*(2), 254–257.

Rugg, M. D., & Curran, T. (2007). Event-related potentials and recognition memory. *Trends in Cognitive Sciences, 11*(6), 251–257. doi:10.1016/j.tics.2007.04.004

Share, D. L. (1995). Phonological recoding and self-teaching: sine qua non of reading acquisition. *Cognition, 55*(2), 151–218. doi:10.1016/0010-0277(94)00645-2

Stein, M., Dierks, T., Brandeis, D., Wirth, M., Strik, W., & König, T. (2006). Plasticity in the adult language system: A longitudinal electrophysiological study on second language learning. *NeuroImage, 33*(2), 774–783.

Suárez-Coalla, P., Álvarez-Cañizo, M., & Cuetos, F. (2016). Orthographic learning in Spanish children. *Journal of Research in Reading, 39*(3), 292–311.

Tamura, N., Castles, A., & Nation, K. (2017). Orthographic learning, fast and slow: Lexical competition effects reveal the time course of word learning in developing readers. *Cognition, 163*, 93–102.

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Мозговые электрические показатели локализации новых слов

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Резюме

Растет популярность исследований развития беглости чтения. Характеристиками беглости чтения являются автоматизация чтения с большей скоростью и точностью, что позволяет читающему упростить процесс высокоуровневого понимания. Ключевым фактором беглости чтения считается создание репрезентаций слов в лексиконе, что в свою очередь дает возможность прямого зрительного распознавания слов. Общепринятым считается факт, что зрительный контакт с новыми словами необходим для создания таких репрезентаций. Однако природа следов в памяти, образующихся вследствие такого обучения, является горячей темой в поведенческой литературе. В то время как некоторые авторы считают, что для создания данных следов достаточно простой зрительной тренировки новых слов, другие полагают, что для создания качественных лексических репрезентаций также требуется тренировка других свойств слов (таких как, например, фонология и значение). Для разрешения этого вопроса требуются более подходящие методы изучения мозга. В этом ключе изучение вызванных потенциалов является эффективным средством для изучения нейрофизиологических механизмов нарабатывания навыка лексического чтения и конкретнее механизмов создания качественных лексических репрезентаций. В данной статье мы обозреваем наиболее заметные исследования вызванных потенциалов создания лексических репрезентаций.

Ключевые слова: чтение, лексикализация новых слов, метод вызванных потенциалов, N400, LPC.

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