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Ulf Schütze, *Language learning and the brain: Lexical processing in second language acquisition*. Cambridge: Cambridge University Press, 2017. Pp. 291.

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The last two decades have witnessed a steady increase in research on lexical processing. Researchers (e.g. Kroll & Dijkstra 2010, Tokowicz 2014) have investigated this field from the perspective of cognitive and neural science as well as second language (L2) acquisition, using neuroimaging techniques to monitor learner's brain when processing another language. A number of models have been proposed in the literature focusing on language comprehension, production, and representation to explain various aspects of lexical processing and the empirical evidence relevant to their evaluation (Tokowicz 2014). However, there is a need for interdisciplinary studies about the dynamics of lexical processing in the mind and the brain. *Language learning and the brain: Lexical processing in second language acquisition* is a compelling work that takes readers on a journey of how a single new word is processed in the brain. It examines how cognitive, linguistic and nonlinguistic factors interact with each other to have an effect on the processing, storing, recalling and producing a new word in L2. The author presents detailed accounts of the biochemical processes in the brain and methodological discussion of current neuroimaging and new media technology, making the book a unique theoretical and applied resource for vocabulary learning and teaching research.

The book is composed of nine chapters, preceded by a general introduction. The introductory chapter highlights a broad array of topics, including how a word is processed from the first encounter by the L2 learner to being committed to the learner's long-term memory, how different parts of the brain operate in the facilitation of lexical processing and production, how lexical acquisition strategies help overcome linguistic and non-linguistic difficulties, and how new media technology facilitates efficient acquisition and recall of a new L2 word.

Chapter 1 explains the form-to-meaning matching process (21), a key concept of meaning recognition and recalling. 'The form-to-meaning relationship of a word is made up by phonemes and lexemes. The phonemes represent the sounds. The lexeme with its lemma and markers must be matched to the phonemes in order to identify the meaning of the word. Later, morphemes are analyzed in order to process the form' (25) When a word needs to be recalled from memory for use in speech, similar form-to-meaning matching process occurs. This chapter also illustrates the three phases of word processing in speech production: first encounter, maintenance, and production. 'First encounter' is the process of creating a synaptic connection between language faculties, memory faculties

and emotions via the senses; 'maintenance' reinforces the synapse-bridge in the recording of a word; and 'speech production' is multi-processes at work in parallel involving simultaneous activation of several brain regions and neurons, rather than the two-dimensional linear processes proposed in previous research.

Chapters 2 and 3 introduce the regions and mechanisms of the brain involved in lexical processing. Physiological structures of memory and biochemical process of synaptic connections are the major focuses. Chapter 2 explains components of working memory and how they function to prolong the duration so that the brain has capacity to identify phonemes of a word and match them to lexemes in the coding, storage and retrieval phase of word processing. The chapter also reviews the current debates on where exactly the brain stores words, giving strong support to the view that the hippocampus region creates the record of a word which is then stored in the non-mesial region. This chapter also outlines the strengths and limitations of four key neuroimaging technologies: PET (Positron Emission Tomography), fMRI (Functional Magnetic Resonance Imaging), MEG (Magnetoencephalography), and EEG (Electroencephalography). These techniques provide 'time sensitive, fine-grained, converging information' (Tokowicz 2014: 20) in examining which brain regions are activated when performing a word task. However, the level of activation is difficult to measure and the spatial and temporal resolution is not high enough to show the details of interaction between phonemes and lexemes. To solve this problem, Schütze employs neurophotonics – an emerging technology which uses photons to measure brain processes at the cellular level, so that researchers are able to see the transmissions between neurons with quality spatial and temporal resolution. This technique will hopefully help, in future studies, understand how neural circuits linked to language faculties operate, though it has not yet been used to analyze language processes.

Chapter 3 focuses on the biochemical processes of long-term memory. It starts with an introduction to the structure of neurons and functions of synapses. Neurons are nerve cells that have the capacity to transmit information. The space between neurons is called a synaptic gap. The synaptic connection can be temporary or permanent. When the connection between neurons is permanent, a synapse is formed (84–85). The author further elaborates the overall network of language processing faculties (e.g. the phonological loop) and memory faculties (e.g. hippocampus) in the brain. These faculties are connected by neuroanatomical circuits which may develop throughout life. The processes of simultaneous activation of neurons and synchronization of neuron activity in the 'converging zones' allows the neural circuits to spring into action and converge information stored in synapses (89). Empirical studies indicate that the processes of working memory are purely chemical and electrical, and that thus the synaptic connection is fragile; however, stimulation such as emotion and repetition increases the likelihood of synapse formation and the strength of a permanent word record.

Chapters 4–6 discuss cognitive load, workings of memory and bilingual lexicon in lexical processing from the perspective of cognitive psychology. Chapter 4 explores the subtle relationship between cognitive load and speech processing

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outcome, focusing on the impact of attention and task factors on working memory. The author applies the dynamic system model to second language acquisition. Given this model, vocabulary learning and grammatical encoding compete with each other and – the author argues – in lexical processing, form and meaning interact positively or negatively with one another depending on the cognitive demand. He further discusses two issues related to cognitive demand: attention and automaticity. Compared with a known word, when a new word is processed, cognitive demand linked to attention is high. Cognitive demand related to automaticity is relatively lower, but it can lead to inaccuracy or insufficient processing of a word due to less attention effort; however, automaticity usually facilitates learning outcome and spares more attention for new words. Factors concerning such learning tasks as word length, lexical and phonological similarity and emotional connotation also affect processing difficulty and whether or not the brain will create a strong record of a word. Finally, the author summarizes previous research on speech errors and the underlying cognitive causes. Lexical errors are a matter of attention, which either prevents lexemes from being activated enough or misorders the activated lexemes; phonological errors are induced by too much competition between similar phonemes; and matching errors result from a combination of incorrect processing of phonological and lexical information.

Chapter 5 compares the workings of memory in first language (L1) and L2 acquisition. Working memory functions basically in the same way in both cases, but there are some differences in speech fluency, accuracy and complexity in L1 and L2 acquisition. Word processing in L1 is largely automatic; however, L2 acquisition is an ongoing process which differs according to the learner's phase of development, learning contexts, individual factors and the word itself. The development of language acquisition changes over a lifetime, involving five sensitive phases: building connections (up to age 1, from age 6 to 8 years/lifelong), developing strategies (around the age of 8 years), analyzing abstractions (from age 11 to 14 years), developing the loop (from age 6 to 16 years), and creating memories (from age 6 to 25 years and then lifelong) (148). Memories linked to vocabulary growth and cognitive abilities, especially the ability of directing, dividing and switching attention, are refined with the development of the brain and age.

Chapter 6 addresses two questions on the mechanism of the bilingual lexicon: Are words in L1 and L2 processed via the same neuroanatomical circuits? Do L1 and L2 share the semantic network? Empirical studies (Willms et al. 2011) with neuroimaging techniques suggest that a speaker largely uses one circuit for lexical processing regardless of the age of L2 acquisition, while in processing grammar, those who acquire L2 between six years and eight must develop a second circuit. Research (Kroll & Dijkstra 2010) on lexical storage and conceptual overlap concludes that L1 and L2 share the semantic network to a certain degree and selection of lexemes and phonemes are tied to both languages.

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Chapters 7–9 highlight spacing techniques and their functions in resolving the linguistic and nonlinguistic difficulties in word processing. Chapter 7 explores how spacing techniques facilitate processing words from short-term gains to long-term memory. Factors such as speed, rehearsal and repetition, as well as distraction are considered when investigating spacing intervals. The author develops a computerized vocabulary trainer to explore how types of intervals (massed/uniform/expanded pattern) affect short-term gains and long-term memory. He concludes that uniform interval is most beneficial to long-term memory, but expanded interval might be a better option for short-term gains. Initial encounter plus four repetitions is considered to be an optimized spacing pattern though it may vary with the learning environments.

Chapter 8 focuses on how spacing techniques help tackle linguistic and nonlinguistic difficulties in word processing. An experiment (Schütze 2015) to examine the influence of word length, phonological similarity and emotional connotation in creating a record of a new word showed that function words need more repetition than content words. Longer and phonologically similar words also need time to be rehearsed and should be repeated often (243). In addition, words with emotional connotation or encountered in an emotional situation can be fast-tracked into long-term memory.

Chapter 9 explains how spacing techniques can be applied in learning and teaching contexts. Intention of learning new words, the number of words to be learnt at a time, and the emotional situation for word learning are three factors conducive to an efficient acquisition and recalling of words. The author claims that the optimal learning approach is repeating new words several times with sufficient break between each repetition so as not to overload the phonological loop with too many words at a time and trying to associate a word with sensory information to create an emotional situation.

This book provides a much-needed bridge between neurophysiology, cognitive psychology and L2 lexical processing, making word processing in the brain accessible to readers with an interest in these fields. The dynamic process of lexical processing in the mind and the brain is elaborated at great length, from the L2 learner encountering a word for the first time to processing the word into long-term memory, recalling the word when needed and producing it in speech. It highlights the role of phoneme-to-lexeme matching at micro-level in creating a word record by activating synapses, the hippocampus, the phonological loop as well as other language and memory faculties, revealing the biochemical interplay specifically linked to lexical processing in the brain rather than second language acquisition in general. A wide-ranging review of empirical evidence supports the view that spaced repetition is an effective facilitator to maintaining words from short-term gains and long-term memory. The vocabulary trainer developed on the basis of initial encounter plus four repetitions proves to be an optimized word learning and teaching strategy. Overall, the book is a valuable addition to the literature on lexical processing and it brings thought-provoking insights to vocabulary researchers.

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REFERENCES

Kroll, Judith F. & Ton Dijkstra. 2010. The bilingual lexicon. In Robert B. Kaplan (ed.), *The Oxford handbook of applied linguistics*, 349–372. Oxford: Oxford University Press.
Schütze, Ulf. 2015. Spacing techniques in second language vocabulary acquisition: Short-term gains vs. long-term memory. *Language Teaching Research* 19.1, 28–42.
Tokowicz, Natasha. 2014. *Lexical processing and second language acquisition*. New York: Routledge.
Willms, L. Joanna, Kevin A. Shapiro, Marius V. Peelen, Petra E. Pajtas, Albert Costa, Lauren R. Moo & Alfonso Caramazza. 2011. Language-invariant verb processing regions in Spanish–English bilinguals. *Neuroimage* 57.1, 251–261.

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Elena Semino & Zsófia Demjén (eds.), *The Routledge handbook of metaphor and language*. London & New York: Routledge, 2017. Pp. xvii + 540.

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This volume is probably one of the first volumes that is entirely devoted to metaphor research over the past several decades. By combing and distilling works in metaphor research, the book offers a comprehensive, insightful and state-of-the-art overview of theories as well as methods and applications related to metaphor research. Given the content of the contributions, this book can be described as a further complement to the previously published *Cambridge Handbook of Metaphor and Thought* (Gibb 2008), highlighting much continuing interest in various topics and types of metaphor research.

The entire volume consists of six parts. Part I traces the main current theories. In Chapter 1, 'Conceptual metaphor theory', Zoltán Kövecses introduces the key concepts related to Conceptual Metaphor Theory (CMT) and explores the latest developments, showing that metaphor may be organized in various hierarchical systems. The following two chapters present two other cognitive theories, Conceptual Blending Theory (CBT) and Relevance Theory. In Chapter 2, 'Figurativeness, conceptual metaphor, and blending', Barbara Dancygier firstly makes a comparison between CMT and CBT, then highlights CMB's advantages in dynamic online meaning construction, which focuses on 'mechanisms of creativity and emergence of new forms expressing new meanings, so it is more