NEUROSCIENCE, PSYCHOLOGY AND THE TEACHING OF VOCABULARY

Adam Jenkins*

ABSTRACT

The field of cognitive neuroscience has advanced to the stage where inferences can be made as to how vocabulary knowledge is stored in semantic networks in the brain. This paper is a demonstration of how research from the fields of psychology and cognitive neuroscience can be applied to language teaching pedagogy and in particular, vocabulary.

脳の中のセマンティックネットワークに、語彙知識がどのように蓄えられていくのかが、認知神経科学の分野において推測出来るようになった。この論文では認知神経科学や心理学の研究成果を語学教育、特に語彙分野に応用する方法を実証する。

Key words: vocabulary, psychology, language, teaching, neuroscience

The brain has been called "the most complex system in the universe" (Başar & Karakaş, 2006, p. 194). Indeed, most of the ways in which our brains give rise to mental life remain unknown. One question of particular interest revolves around how the brain is able to process language. Recent improvements in technology are beginning to allow us new insights into its workings (Dörnyei, 2009). Research from several fields of study is uncovering how language and vocabulary are stored. This research has implications for second language acquisition and language teaching in the analysis and critical evaluation of language learning and teaching strategies. This paper is intended as a brief exploration of the concept of semantic networks drawing on research from the domains of psychology, linguistics and cognitive neuroscience with a view to applying it to the critical evaluation of methods used to teach vocabulary in EFL contexts.

Vocabulary in the brain

The human brain is a highly connected and tightly packed body of cells that are responsible for the storage and processing of information. Exactly how the brain does this, for the most part remains a mystery. However, several advances have been made towards understanding how the brain works. As Gazzaniga, Ivry and Mangun describe, "The gray matter forms a continuous cortical sheath enshrouding a seemingly homogeneous mass of white matter" (2002, p. 64). This crude anatomical observation can be taken a step further when considering the difference between gray and white matter. The gray matter appears to be more responsible for information storage with white matter engaged in information transmission. This shows that at least two operations are critical to the brain functioning, the storage and transmission of information.

In his analysis, Caramazza (1996) describes a model of vocabulary in the brain organised by a series of interconnected nodes. He describes these nodes on three level. The "semantic features" level holds the conceptual features of the word, the "lexical nodes" hold the lexical

* Received March 2, 2012
*Center for Student Education Resource

2012年3月2日受理
* 教育開発センター

items (i.e., the words), and the "phonological segments" level where the word is linked to its respective phonology (Caramazza, 1996, p. 485). This node-based model is misleading in that the concept of a *node* suggests a discrete set of neurons dedicated to the storage of a particular vocabulary item. In reality there appear to be no physical boundaries between words although words with similar attributes can be found in close proximity in the brain (Damasio, Grabowski, Tranel, Hichwa, & Damasio, 1996). Although there appear to be no discrete nodes that relate to single lexical items, on a larger scale, it appears that the neural representations of the mental lexicon are organised in a logical way. Evidence for this comes from both studies in patients with brain lesions and brain imaging studies (Damasio et al., 1996). One study found that some concrete vocabulary items are stored in various parts of the temporal pole and inferior temporal lobe. Patients who had lesions to these areas presented symptoms of anomia that was limited to a specific category: either the names of persons, animals, or tools (Damasio et al., 1996). The neural requisites for the naming of the stimuli presented was further supported in the same study by Positron Emission Tomography (PET) scan data from individuals who had no brain lesions. Furthermore, although the patients with lesions could not name the stimuli, they were able to provide functional descriptions of the stimuli presented. This shows that the patients did possess knowledge of what they were perceiving despite their inability to assign a word to the stimulus (Damasio et al., 1996).

Further evidence supports the view that vocabulary is stored in the brain in a semantic network. In a study by Deese (1959), subjects were presented with a list of words and later asked to recall as many words as they could. Deese (1959) recorded regularity in verbal intrusions when asking subjects to recall words from the test list. If several words were of a similar semantic category, during recall, subjects reported words that did not appear on the test list but were semantically related to words that did appear on the test list (Deese, 1959). Another study found that by giving subjects a test list filled with word associates to a particular target word, subjects incorrectly recalled the target word as being on the list (Roediger & McDermott, 1995). These studies suggest that in the semantic network of these subjects, words are stored in close proximity. For example, the words *meow*, *fur*, *tail*, and *paw*; would be stored in close proximity to the word *cat*. If you were to present any one of these words, you would have a small chance of eliciting the target word. However, in the study by Roediger and McDermott (1995), multiple words were used with each word activating the semantic network a little, but with the cumulative effect being the activation of the neural representation of the target word to the degree that it was recalled as a false memory. The reason that this phenomenon is possible is because of the spreading activation across the semantic network. Although the words in the lists may not sound similar, there are several shared semantic elements in each of them. This evidence suggests that vocabulary is stored in the brain in an organised way, sharing semantic assets with other vocabulary items.

Some other links present in the mental lexicon relate to how vocabulary items are used to produce language. Levelt (1993) has suggested that the mental lexicon has grammatical features embedded in the representations of words. For example, whether a word is a verb or a noun would be a label assigned to the vocabulary item. It is beyond the scope of this paper to go into lengthy discussion about the grammatical aspects of vocabulary, however it is important to note that the connections of vocabulary items to both meaning and the mechanisms for explicit communication (reception and production) are also important aspects for consideration in any model of the mental lexicon.

It is also important to recognise the differences between first and second language learners' acquisition of vocabulary. The main difference is that whereas first language learners are building their semantic networks from a zero starting point, second language learners already possess a functioning set of semantic networks from their first language. For the purposes of this discussion, the important consideration is that new vocabulary will to some degree

become mapped onto the existing semantic networks resulting in the observable phenomenon of L1 transfer.

Implications for language education

The discussion thus far has several implications for language teaching. First, there is the notion that vocabulary teaching methods should attempt to expand the learner's semantic network building associations between the words and their meanings and contexts. Pedagogically, this supports the teaching of vocabulary in lexical sets organised by meaning. Language courses that have lessons with themes and a topic for that lesson are an attempt to achieve this goal and such organization is commonplace in modern textbooks. The second notion is that vocabulary should not be stored in the brain as an outlying branch of the L1 semantic network. The implication is that simply associating an L2 vocabulary item to a corresponding L1 word will not be sufficient for second language acquisition. Such learners would be able to translate words well but could be expected to fail at tasks requiring deeper processing of the semantic features of the L2 vocabulary.

It is not my intention to propose a new brain-based method for the teaching of vocabulary. Instead, I would like to focus on the critical evaluation of existing methods from a non-traditional viewpoint. Alferink & Farmer-Dougan (2010) have argued against assertions that neuroscience will lead to a new *neuroscientific* pedagogy and that evidence from the neurosciences support existing teaching practices. The analysis below is an attempt to evaluate two existing methods of vocabulary instruction based on evidence from the neurosciences regarding the development of the L2 learners' semantic networks. First, the use of vocabulary lists/flashcards will be analyzed. Following this, the vastly different approach of extensive reading will be examined and the claim that extensive reading is beneficial to vocabulary acquisition, explored.

Word lists/Flashcards and Extensive Reading

Word lists link the meaning of a target word in the L2 to a reference word in the L1. In a word list there are usually several words presented with their L1 correlates. Flashcards work on a similar principle with the target and reference words appearing on opposite sides of the same card. If the target-reference word link is the only link made, then the target word will be attached to the semantic network as an outlying branch. This can be the beginning of the process of learning the target item however, without the L1 word as a stimulus, we can expect that target word recall will be difficult. However, there are ways in which the effectiveness of word lists and flashcards can be enhanced, such as arranging the words into lexical sets. Lexical sets promote the development of a semantic network by allowing connections to be made between these words. Additionally, if there is semantically deeper processing, this may also facilitate associations between the word sets and the shared semantic assets or nodes as Caramazza (1996) termed them. Such deeper processing can be achieved by incorporating on each flashcard one or two model sentences of how the word is used. This could be further improved if the model sentences contained another word from the same flashcard set.

Extensive reading is another method of vocabulary acquisition. Extensive reading involves the learner reading copious amounts of text containing language that is just below or at his current ability. The implications for vocabulary acquisition lie in the belief that as the learner reads more and more, his understanding of vocabulary items will improve and moreover, the learner's ability to make meaningful inferences about unknown vocabulary items will also improve (Day & Bamford, 1998). The advantages of extensive reading stem from the contextual information supplied in the readings. Words are presented in a variety of authentic contexts allowing the semantic network to grow with each occurrence of the target words adding contextual and nuanced information to the semantic network. This information is often different from the translated *equivalents* of the target word. Multiple meanings and usages will also be explored incidentally throughout the reading process and the words will be learned more completely. This can be contrasted with word

lists and flashcards where many words are learned to a lesser degree. In sum, extensive reading serves as an effective way to extend the semantic network of words that are already partially known but not fully developed.

Conclusion

Research from fields outside of linguistics such as cognitive neuroscience and psychology, contributes greatly to our understanding of how language is represented in the brain. Insights gained from this research provide new tools that allow language teachers to evaluate language teaching pedagogy more effectively. Although language teaching professionals may already have an intuitive sense of what works, the knowledge gained from neuroscience research allows these intuitions to be placed under scientific scrutiny. In the example analyses given above, it can be concluded that differing methods contribute to vocabulary acquisition in different ways. The question of which method of vocabulary acquisition is better, is a question of quality versus quantity. Word lists and flashcards may provide more vocabulary items in a short period of time (quantity) where extensive reading enhances the understanding of each word (quality). Used in conjunction, word lists and flashcards may provide the vocabulary frame upon which extensive reading can then elaborate into a vast and complex understanding of the target word. As technology continues to develop, research will continue to provide new insights into how the brain processes language and vocabulary.

References

1) Alferink, L. A., & Farmer-Dougan, V. (2010). Brain-(not) Based Education: Dangers of Misunderstanding and Misapplication of Neuroscience Research. *Exceptionality*, *18*(1), 42–52. doi:10.1080/09362830903462573
2) Başar, E., & Karakaş, S. (2006). Neuroscience is awaiting for a breakthrough: An essay bridging the concepts of Descartes, Einstein, Heisenberg, Hebb and Hayek with the explanatory formulations in this special issue. *International Journal of Psychophysiology*, *60*(2), 194–201. doi:10.1016/j.ijpsycho.2005.12.010
3) Caramazza, A. (1996). The brain's dictionary. *Nature*, *380*(6574), 485–486. doi:10.1038/380485a0
4) Damasio, H., Grabowski, T. J., Tranel, D., Hichwa, R. D., & Damasio, A. R. (1996). A neural basis for lexical retrieval. *Nature*, *380*(6574), 499–505.
5) Day, R. R., & Bamford, J. (1998). *Extensive reading in the second language classroom*. Cambridge, U.K.; New York: Cambridge University Press.
6) Deese, J. (1959). On the prediction of occurrence of particular verbal intrusions in immediate recall. *Journal of Experimental Psychology*, *58*(1), 17–22. doi:10.1037/h0046671
7) Dörnyei, Z. (2009). *The psychology of second language acquisition.* Oxford: Oxford University Press.
8) Gazzaniga, M. S., Ivry, R. B., & Mangun, G. R. (2002). *Cognitive neuroscience : the biology of the mind*. New York: Norton.
9) Levelt, W. J. M. (1993). *Speaking: From intention to articulation*. the MIT press.
10) Roediger, H. L., & McDermott, K. B. (1995). Creating false memories: Remembering words not presented in lists. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *21*(4), 803–814. doi:10.1037/0278-7393.21.4.803