FAB 9 Study Sheet #4 – Language Processing

From Curtis Kelly's chapter in *Innovations in Teacher Training*, Springer Press (in press)
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Topic 4: Embodied simulation

In 2012, a book came out that I believe is bound to have a huge impact on TESL training. Ben Bergen's *Louder than Words: The New Science of how the Mind Makes Meaning* is not the only book on embodied cognition, but it is the most relevant and accessible for us. In it, Bergen answers the age-old question of how the brain processes language. The mystery of how we make meaning has finally been solved. According to Bergen, who also summarizes the extensive research behind the theory, we process meaning through what he calls embodied simulation. "Embodied" does not refer to things happening in your body per se, but rather, in the cortices that interact with your body: the visual, auditory, somatosensory, olfactory, and the motor cortices.

In short, when you hear or read a word, especially of an object or an action, the same neurons fire in your sensory cortices that would fire if you actually experienced that scenario. For example, within milliseconds of someone saying "a tiger jumped on the antelope" your brain is already subconsciously conjuring an image of a tiger in some African setting running and pouncing with outstretched claws and your motor areas for pouncing and stretching fire up. Unless, of course, you are from Detroit or Osaka, in which case you might be conjuring an enraged baseball player. The words "coffee" or "cinnamon" cause the olfactory cortex to light up (Gonzalez et al, 2006). For language referring to actions, such as "he opened the door," networks in the motor cortex for the same muscle actions fire as well. They fire at a lower amplitude than when actually opening a door, so that your hands do not start flaying around. In other words, on hearing language, the same neural networks to process visual, auditory, speech, olfactory, and motor actions connected to whatever actions the word represents, fire again, as if we were actually doing or sensing that action. This might sound similar to the way mirror neurons work, and I suspect that what we identified as mirror neurons in the nineties are really just regular neurons making meaning through simulation.

Note that the same sensory simulating seems to happen with more abstract words as well, such as "justice," "organized," or "peaceful." According to Lakoff and Johnson (2008) and Bergen (2012) this probably happens through metaphors. If you hear "Timberlake's velvety voice," your visual networks for trees, and water will fire initially, and then for Justin. "Voice" will make that part of your motor area active and for metaphor, "velvety" will activate the somatosensory network for the feel of velvet.

We can also simulate things that we have no real memory of, such as a "flying pig" (Bergen, 2012), by amalgamating memories of flying and pigs (or for some people, English pubs). In fact, though we do not have the evidence to say for sure yet, it seems likely that all language processing might start with embodied simulation. I suspect that this might be the case, but after repeated simulating, the words or other conditions might become automaticized, maybe in the association cortex, and simulating plays a less important role.

If you have not realized it by now, the way our brain processes language, which has been called our "latest, greatest cognitive achievement" (Campbell, 2015b, p. 21) is another example of neural reuse, a hypothesis discussed in an earlier section. The brain uses numerous sensory, motor, relational, and emotional areas, all originally developed for other tasks, to do this amazing thing, language, a tool that allows us to shape affordances in others. That is why it does not make sense to say 'language is "located" in the Brocas or Wernicke areas,' or even in the left hemisphere, as once thought; language is spread all across our brain. Talking about "where" things happen, as if there was a one-to-one kind of association

between function and location in the brain is no longer appropriate. This is not to say that the Brocas area does not have an important role in language – it is critical – but it is telling that Brocas area is also activated for other processing that has nothing to do with language, a fact we seemed to have glossed over in the past. Brain parts seem to have skills recruited for multiple functions, rather than specific ones.

So what does this have to do with effective language teaching? We are not sure yet, but there are some implications. It is probably why multi-sensory input and rich narrative formats, as opposed to memorizing lists, are so effective in vocabulary learning. It might also explain how reading automatization occurs; it is the strengthening of sensory networks activated by language. It probably explains the reasons for L1-L2 errors, since L2 language representations get integrated into the same sensory networks L1 representations are part of. It certainly explains the subvocalization (involuntary movements in the larynx and articulation muscles) that occurs during silent reading and listening, and also why subvocalization plays a role in short-term memory. It supports experiential learning. And finally, it fully validates the constructivist theories of learning and language, if they are still really need validating. This is not to say Bergen's book (2012) does not have critics, but most of the criticism I have read is calling for broadening, rather than rejection, of the theory.

Bergen, B. (2012). *Louder than words: The new science of how the mind makes meaning*. Basic Books.

Campbell, G., (2015, November 23). Interview with Dr. Richard Anderson, author of *After Phrenology: Neural Reuse and the Interactive Brain*. Brain Science Podcast transcript, Episode 124. Originally aired 07/28/2015. Retrieved from http://brainsciencepodcast.libsyn.com/podcast

González, J., Barros-Loscertales, A., Pulvermüller, F., Meseguer, V., Sanjuán, A., Belloch, V., & Ávila, C. (2006). Reading cinnamon activates olfactory brain regions. *Neuroimage*, *32*(2), 906-912.

Lakoff, G., & Johnson, M. (2008). *Metaphors we live by*. University of Chicago Press.