

## Language research needs an “emotional revolution” AND distributed models of the lexicon

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Pavlenko urges the community of language researchers to modify their conceptions of the mental lexicon, based on findings from bilingualism and emotions. She makes a compelling case. While reading her article, one can temporarily forget that in contemporary practice, emotion is not regarded as relevant to the theoretical question of the structure of the mental lexicon.

Q1 Scientists’ view of cognition and emotion as non-intersecting or even antithetical spheres has historical roots that were apparent as far back as the founding of the Royal Society in 17th-century England (Fox-Keller, 1985). In mid-20th century, the cognitive revolution re-introduced a focus on thinking after decades of behaviorism, with the new insight that thought was mental calculation, steps in a computer program. Chomsky (1965) defined a new field of linguistics for the second-half of the 20th century by insisting that language was not primarily a communication system, but a mental algebra in which structure, not content, determined correct form. In Chomsky’s autonomy of syntax hypothesis, language was viewed as a separate system from cognition, and thus was doubly unconnected to emotion.

Pavlenko’s target article and the research she cites represent a break with tradition, but a break that’s long overdue. Language researchers are behind the curve, since the “emotion revolution” occurred in the cognitive sciences a decade ago. Cognitive science’s tight connection with artificial intelligence and abstract reasoning diminished with the rise of cognitive neuroscience in the 1990s. The popularity of cognitive neuroscience was fueled by the technological innovations of neuroimaging (PET and fMRI, e.g., Posner, Petersen, Fox and Raichle, 1988), but this young field was strongly influenced by its parent discipline, neuroscience. Neuroscience has traditionally studied animal behavior, and thus the brain mechanisms underlying animals’ motivational and emotional systems are core questions in neuroscience. The emphasis on emotions as an important control system can be seen in major books of the 1990s such as LeDoux (1996) and Panksepp (1998). A second influence on the emotional revolution was Antonio Damasio’s neuropsychological studies, popularized in *Descartes’s error*. Damasio (1994) argued that not only are

cognition and emotional not independent, but high quality decision making is impossible for individuals who have had lesions to brain areas that register emotional valence of stimuli.

The emotion revolution has not hit psycholinguistics. A check on chapter titles and indices in handbooks and textbooks reveal an almost complete lack of reference to emotion. Some important exceptions are worth noting. A subgroup of researchers have long argued that language learning in the first years of life is part of infants’ drive to connect with caregivers (Bloom and Beckwith, 1989; Fernald, 1989; Locke, 1993). Indeed, infants’ earliest comprehension of speech depends on their sensitivity to the emotional tone of utterances (Fernald, 1989). Within the field of second language learning, Schumann (1997) has observed that high achievement depends on motivation, whether it is motivation to connect with peers or motivation to develop personal, intellectual capital.

Although the researchers just mentioned are highly respected, and well cited by their peers, their perspective is not mainstream. Dominant models of language learning and processing were developed without taking emotional resonances into account. Below I evaluate obstacles to implementing Pavlenko’s proposals, and make additional suggestions for incorporating emotion into our models of language processing.

Pavlenko urges theorists to consider emotion words as a separate class of words in the mental lexicon, represented and processed differently from abstract and concrete words. But what does it mean for a group of words to be considered a separate class of words? Models of the lexicon should not be constructed the way architects build a house, with rooms designated for eating, sleeping or washing. The contemporary view of the lexicon, for both monolingual and multilingual models, is that words’ meanings are distributed patterns of neural activation (Seidenberg and McClelland, 1989; De Groot, 1992; Finkbeiner, Forster, Nicol and Nakamura, 1994). Q2 The processing units underlying these neural activation patterns may be activated for many words we refer to as “emotion words”. But in a lexicon with distributed representations, a word’s designation as an emotion word is descriptive, not architectural.

Implementing theories of the lexicon with distributed representations will facilitate Pavlenko's second recommendation: incorporating the finding that bilinguals' emotion concepts can be distinct in their two languages. De Groot's Distributed Conceptual Feature Model already achieves this. Her model allows the meaning representations of a word in L1 to have complete overlap with the meaning representations of L2, to have partial feature overlap, or to have no feature overlap. Finkbeiner et al. (2004) added some assumptions to De Groot's model and created the "Sense Model", designed to capture the fact that most words are polysemous. L1 and L2 words may be translation equivalents (and have strong links to the same semantic features) for one sense but not in another, as in Pavlenko's analysis of *envy* and its translation in Russian, *revnost*. In the Sense Model, an L1 word may activate three different senses, and an L2 word can activate none, some, or all of these. It thus seems that distributed models of the lexicon can accommodate Pavlenko's second challenge.

In her third challenge, Pavlenko urges theorists to construct models of the lexicon such that words in different languages can have different levels of emotional intensity, whether or not they have similar or distinct semantic features. Consider the finding that emotional expressions can elicit larger skin conductance amplitudes in one language than in another (Harris, 2004). Following De Groot's (1992) model, or Finkbeiner et al.'s (2004) Sense Model, one could propose that childhood reprimands may elicit large SCRs in Spanish, but not in English if the Spanish reprimands have stronger links to semantic features that signal threat or fear of punishment.

What are these semantic features? Traditional models assumed that semantic features are inert symbols, as when the semantic features of "bachelor" were defined as +male, -married (Katz and Fodor, 1963). The findings that a word can produce a frisson of fear in one language, but a yawn in another, suggests that new ideas about semantics are called for, such as those advocated by "embodiment" theorists (e.g., Barsalou, 1999).

Considerable emotion is carried by phrases, such as insults and endearments (Harris, 2004). The emotionality of phrases highlights another shortcoming of traditional conceptions of the lexicon, the "words and rules" assumption (Pinker, 1999). According to the words and rules theory, sentences are produced by selecting single words out of a dictionary-like list, and then putting these into sequences by consulting grammatical rules. This model doesn't survive simple introspection, and conflicts with psycholinguistic and language acquisition work (Tomasello, 1996), yet continues to be influential. Producing sentences out of single words is a formidable task, and is more characteristic of foreign language learners than the universal process envisaged by Pinker. In ordinary fluent speech, words come to us already carrying

their typical left- and -right contexts. The more fluent we are, the more we draw on formulaic expressions and already packaged chunks (Wray, 2002). Q4

A distributed lexicon will have advantages over the dictionary-like "words and rules" conception by allowing words to be stored with their sentential context of occurrences (Harris, 1998; Solan, Horn, Ruppin and Edelman, 2005). Words represented with links to their typical linguistic contexts will help explain the ever-present influence of context on word meaning. For example, in the study of Spanish-English bilinguals reported in Harris (2004), the list of neutral words included "finger", because finger had been classified as mid-range on the pleasantness scale normed by Toglia and Battig (1978). But Toglia and Battig's participants rated hundreds of words in a setting that induced a single-word focus. In the context of word lists containing taboo words, finger took on emotional connotations that led to increased skin conductance amplitudes.

The emotionality of words and phrases suggests that their neural patterns might be associated not just with the meanings of the other words in their sentential environment, but with the sounds, smells and emotional resonances of the extra-linguistics environment. My colleagues and I have proposed the "emotional contexts of learning hypothesis": language comes to have a distinctive emotional feel by virtue of being learned, or habitually used, in a distinctive emotional context (Harris, Gleason and Aycicegi, 2006). As noted by Pavlenko, an implication for age-of-acquisition effects is that emotional language isn't limited to the language one learned in childhood (although childhood is certainly "the mother of all emotional contexts"), but that the emotional resonances of a language can develop throughout the lifetime, to the extent that speakers use language to achieve socio-emotional goal. The implication for models of the lexicon is that words' meanings (and especially phrasal meanings) are not limited to inert semantic features, but are linked to richly embedded autobiographical memories (Marian and Neisser, 2000).

Distributed models of the lexicon can form the initial starting point for modeling these effects. Contemporary distributed models developed out of connectionism, the neurally-inspired modeling program of the 1980s (Seidenberg and McClelland, 1989). Connectionism made no assumptions about what co-occurrences of information-types would emerge from the brute-force regulation-extraction learning mechanisms. Linguists and psycholinguists have long observed that words can take on the connotations of the meanings of words with which they co-occur (MacWhinney, 1989). Connectionist and statistical learning mechanisms can model this contextual shading of meaning (Harris, 1990; Lund and Burgess, 1996). I argue that the strong visceral associations of emotional words and phrases is a natural result of Q5

the principle that everything of potential relevance can become associated during learning. The neural structures underlying human language are less modular and more integrated with diverse types of information than has been traditionally assumed.

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