

Brain, Language, and Environment

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Research results from seemingly unrelated domains are converging on an aspect of human behavior that will be of critical interest to cognitive neuroscientists in the next century: the intimate interaction of brain, language, and environment. Our principal argument is that brain–language relations cannot be fully understood absent an understanding of the reciprocal influences of the environment on brain–language relations and brain–language relations on the environment. We predict that future research in the cognitive neuroscience of language will, of necessity, include this new domain of theoretical relevance—the mutual influence, that is, the dynamic interaction, of the neurally based rules of linguistic grammar and the neurally based rules of social interaction, which we call the “social grammar.” The present paper provides evidence from the following sources to support our prediction: language learning, theory of mind, behavioral neurology, and sociolinguistics.

The most obvious example of the influence of environment on language is in the learning of one’s first language. The social context in which one learns a first language obviously influences what one learns. (For example,

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children in English-speaking environments learn English; children in Japanese-speaking environments learn Japanese.) Moreover the language context interacts with brain development to set neural constraints on the ability to comprehend and produce other languages. Werker et al. (1995) have noted demonstrable loss in the ability to discriminate nonnative phonemic distinctions as early as the first year of life. Furthermore, if a second language is acquired after age 4, a limitation in the appreciation of aspects of that language's morphosyntax is evident by nonnative proficiency as an adult (Johnson & Newport, 1989). Training can minimize such distinctions between nonnative and native performance, however. For example, McCandliss and colleagues (1999) have developed a program to enable Japanese speakers to distinguish /l/ and /r/. That such training can be effective is further evidence for the influence of environment on language.

Another set of examples of the mutual dependence of social behavior and brain–language relations comes from research in the cognitive neuroscience of “theory of mind.” Theory of mind refers to the ability to understand someone else's intent (Premack & Woodruff, 1978). Impairments in the ability to produce or comprehend indirect requests, humor, sarcasm, or other aspects of idiomatic or metaphoric language use, as can occur following right hemispheric damage (Brownell et al., 1986), can seriously disrupt the ability to understand a speaker's intent, disturb normal social conversation, and interfere with normal social interaction.

A dramatic clinical example of the intimate interaction of brain, language, and environment comes from a different realm of behavioral analysis: a single case study recently completed of an association between language and the “environmental dependency” syndrome (Tanaka et al., 1999). The environmental dependency syndrome refers to a peculiar pattern of actions linked to frontal lobe dysfunction in which patients display an exaggerated dependency on the environment for behavioral cues (Lhermitte, 1986). We examined an 84-year-old woman with an acute left frontal lobe infarction who entered the hospital with striking imitation behavior. After two weeks her imitation behavior disappeared, but an equally striking new behavior emerged. In the presence of others, she would call out the names of objects in the room, and also call out the actions and gestures of people in the room, even though she was not asked to do so, and even though she was asked to stop. She appeared altogether unable to prevent herself from speaking aloud in response to specific environmental cues.

The argument we are making in this paper, which we believe will find its place in future research in the cognitive neuroscience of language, echoes arguments made previously in Russian research. An extensive series of studies, starting decades ago with Vygotsky and extending through Luria to Bakhtin, elegantly summarized by Wertsch (1998), demonstrates how language as a cultural tool influences expectations of social groups, ultimately setting constraints on understanding. In turn, these constraints contribute to

the development of social rules which, themselves, influence language use. Military propaganda and commercial advertising are the best known representatives of this influence. Wertsch concludes that the proper study of “the relationship between mind and sociocultural setting” is not only to look at the extremes (neurobiology, on one hand; society, on the other) but also “to employ a unit of analysis that focuses precisely on how these forces come into dynamic contact.” We are here making the same argument for the study of brain, language, and environment, and we suggest that the tools (theoretical, methodological, technological) are at hand, and the time is ripe, for the development of this field of research.

Earlier in this paper we spoke of the “social grammar.” By social grammar we mean the internalized, neurally conditioned set of rules that order and constrain interactions between and among individuals and their environment(s). As a child grows into adulthood, a neurally based social grammar develops whereby cognitive and emotional systems are conditioned by environmental cues, and the cognitive capacity to control the environment and plan ahead emerges. A research theme we believe likely to be found on the research agenda of cognitive neuroscientists in the future is the study of the dynamic interaction between the social grammar and the linguistic grammar.

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