Aspects of human language: Where motherese?

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Abstract: Human language is a peculiar primate communication tool because of its large neocortical substrate, comparable to the structural substrates of cognitive systems. Although monkey calls and human language rely on different structures, neural substrate for human language emotional coding, prosody, and intonation is already part of nonhuman primate vocalization circuitry. Motherese could be an aspect of language at the crossing or at the origin of communicative and cognitive content.

To paraphrase Gibson (1995), Falk succeeds here in collecting and assembling pertinent new pieces to help solve the language origins puzzle. In presenting possible alternatives to suggestions that language could not have emerged from an earlier primate communication system, Falk takes a view that contrasts with hypotheses emphasizing the origin of language as a cognitive adaptation. As suggested by Jerison (1977; 1986; 1988; 1991), human language as an adaptation for communication is peculiar because of the huge amount of nervous tissue involved in human language processing. Communication exists everywhere in the animal kingdom and involves few nervous cells. As a consequence, if human language evolved as a cognitive adaptation comparable to vision or hearing and most probably to a multimodal "supersensory" system for knowing the outside world, then the huge amount of neural tissue involved in language is understandable and is comparable to the situation that prevails in other cognitive systems. This view is close to the one of Geschwind (1965; 1970) who argued that language is based on the expansion of angular and supramarginal gyri in humans. The angular gyrus region in particular receives input from all cortical sensory areas and thus supports cross-modal integration. Furthermore, the anatomical and functional relationships between the supramarginal gyrus and Broca's area in humans suggest that language processing is related to working memory networks (Aboitiz & Garcia 1997a; 1997b).

Besides these views of human language with roots in noncommunicative sensory function, in the building of a world image or as a model of "sensory enhancement" (Jerison 1986), another view relates the emergence of language to nonlinguistic motor actions and their representation. Rizzolatti et al. (1996) observed that, in the premotor cortex of the monkey (area F5), neurons that elicit the performance of an action also discharge when the monkey observes a similar action made by another monkey or by the observer. The activity of these "mirror" neurons represents the observed action and is the source of the understanding of motor events. Interestingly, the observation of motor actions activates the posterior part of the inferior frontal gyrus in man (Broca's area), a region most probably homologous to area F5 in monkey. Rizzolatti et al. (1996) therefore suggested that human verbal communication derives from a prior communication system essentially involving the recognition of hand and face gestures. The hypothesis that action recognition and verb generation share a common functional architecture in the inferior frontal gyrus has recently been successfully tested (Hamzei et al. 2003).

In a comparable scenario, Wilkins and Wakefield (1995) suggested that linguistic capacity in humans is separated from communicative abilities and that language-centered cortical areas initially evolved to fulfill complex manual (nonlinguistic) activities. These cortical regions, including Broca's area and Wernicke's parieto-occipitotemporal complex, were subsequently reused ("evolutionary reappropriation") for linguistic activities.

A detailed discussion of these alternative hypotheses is out of our scope. The point here is that all of them require large portions of the neocortex as structural substrate for human language emergence. Moreover, in elaborating these hypotheses, researchers look at what constitutes the anatomical substrate of human language and then look at the function of homologous structures in nonhuman primates. Based on Falk's views, it would be possible to do the reverse – that is, look at what constitutes neural substrate of monkey vocalizations and then search to discover whether homologous structures are involved in human language.

Neural structures controlling vocal calls in monkeys and speech in humans only partially overlap. The first are mostly subcortical structures and involve diencephalic, midbrain, and brain stem components. The cortical structures that play a role in monkey phonation, the anterior cingulate cortex (anterior limbic mesocortex) and the supplementary motor area (neocortical area), are on the mesial surface of the hemispheres (Ploog 1988; Sutton & Jürgens 1988). Human speech is essentially controlled by the activity of a circuit formed by the Wernicke's and Broca's regions, which are located on the dorsolateral part of the neocortex. The neocortical face area on the lateral surface has a role in motor control over oral and laryngeal structures in monkey, chimpanzee, and gorilla, but with the exception of the cingulate cortex, the role of the neocortex in nonhuman primate vocalization appears to be negligible. In addition, there is a direct connection between the primary motor cortex and the laryngeal motoneurons in humans. Such a connection is lacking in monkeys (Deacon 1989; Sutton & Jürgens 1988). It seems therefore that most of the brain structures involved in human speech control are dispensable for monkey call production.

It must, however, be emphasized that limbic and neocortical regions that play a role in nonhuman primate phonation circuitry also play a role in specific aspects of human language. The anterior cingulate cortex is responsible for the voluntary initiation of voice in monkeys. Monkeys as well as apes have voluntary control of the initiation of species-specific calls, although they have very restricted control of acoustic structure of phonations (frequency and amplitude modulation). In contrast, the human anterior cingulate cortex is responsible for the control of prosody and intonation and for the coordination between speech and emotional content. The supplementary motor area participates in the initiation of global motor programs and seems to be involved in the initiation of behavioral patterns not directly triggered by external stimuli. In humans, damages to this area in the dominant hemisphere cause transient mutism and dysarthrophonia (Jürgens 1988; Penfield & Roberts 1959; Ploog 1988). Although we cannot demonstrate whether there is a link between monkey calls and motherese, it appears that the neural substrate for emotional coding, prosody, and intonation, and hence for essential aspects of motherese content, is largely present in nonhuman primate phonation circuitry. It has been suggested by Deacon (1989) that the vocalization circuits that play a central role in nonhuman primate vocalization became integrated into the more distributed human language circuits. These old circuits were neither eliminated nor supplanted, but still play a role at some level of the language processes. It is possible that motherese illustrates one aspect of human language besides other aspects involving communicative as well as cognitive processes. The ideas developed by Falk could therefore be seen as an interesting possible link between noncommunicative (cognitive) human language and communicative human language emergence hypotheses.

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