

From hand actions to speech: evidence and speculations

L. Fadiga^{1,2}, A. C. Roy^{1,3}, P. Fazio¹, L. Craighero¹

¹ University of Ferrara, Italy

² The Italian Institute of Technology, Italy

³ Institut des Sciences Cognitives, Bron, France

This paper reviews experimental evidence and presents new data supporting the idea that human language may have evolved from hand/mouth action representation. In favor of this hypothesis are both anatomical and physiological supports. Among the anatomical ones, is the fact that the monkey homologue of human Broca's area is a sector of ventral premotor cortex where goals are stored at representational level. In this region neurons have been found that respond to action-related visual stimuli such as graspable objects (canonical neurons) or actions of other individuals (mirror neurons). Among the physiological ones, are some recent findings by our group showing that during speech listening the listener's motor system becomes active as if she were pronouncing the listened words; the TMS-induced temporary inactivation of Broca's region has no effects on either phonological discrimination or on phonological priming tasks; hand gestures where the hand is not explicitly visible (i.e. animal hand shadows) activate the hand-related mirror neuron system, including Broca's

region; frontal aphasic patients are impaired in their capability to correctly represent observed actions. On the basis of these data we strengthen the hypothesis that human language may have evolved from hand action representation. We conclude, by speculating that the property of recursion, considered peculiar of human language, may have been introduced to hand actions by the fabrication of tools. The addition of this property to our action system may represent a critical intermediate step during the development of our verbal communicative system.

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