

1. Project Summary

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Project Summary ²⁰

Objectives (maximum 1000 characters)

The goals of MIRROR are: 1) to realize an artificial system that learns to communicate with humans by means of body gestures and 2) to study the mechanisms used by the brain to learn and represent gestures. The biological base is the existence in primates's premotor cortex of a motor resonant system, called mirror neurons, activated both during execution of goal directed actions and during observation of similar actions performed by others. This unified representation may subserve the learning of goal directed actions during development and the recognition of motor acts, when visually perceived. In MIRROR we investigate this ontogenetic pathway in two ways: 1) by realizing a system that learns to move AND to understand movements on the basis of the visually perceived motion and the associated motor commands and 2) by correlated electrophysiological experiments.

Description of the work (maximum 2000 characters)

The project will investigate the association between visual information and motor commands in the learning, representation and understanding of complex manipulative gestures. The reference scenario is that of a person performing goal driven arm/hand gestures such as pointing, scratching a body part, bringing food to the mouth etc. At the end of the project the artifact will be able to learn how to perform and recognize this kind of actions. We intend to proceed with two different methodologies: 1) implementation and use of an artificial system and 2) electrophysiological and behavioral experiments. In the initial part of the project the experimental set-ups will be realized namely 1) the artificial system (robot) and 2) the biological data acquisition. The robot is composed of a binocular head, a torso, an anthropomorphic arm with a hand. Most of these components are already available and we will concentrate on the realization of an arm and hand with elastic properties (possibly included in the actuators) and with torque/force sensors at the joints. The biological set up will consists, initially, of a "data-glove-like" and a pair of cameras. Experiments will be carried out to better understand the role of the unified visuomotor representation formed by mirror neurons in learning and recognizing motor acts, and how these acts are matched onto the observer motor repertoire. The degree of modulation of mirror neuron discharge recorded when the monkey sees its own hand will be contrasted with neuronal discharge evoked by observation of other's hand, and during the execution of hand actions without visual feedback. The biological data will guide the artifact implementation. Finally the "artificial neurons" of the artifact "brain" will be analyzed in terms of motor, visual and visuomotor properties and the data will be compared with those obtained during recording experiments performed in monkey parietal and frontal cortices.

Milestones and expected results (maximum 500 characters)

Milestones are: 1) the artifact (month 12); 2) the demonstration that the artifact generates and understands a repertoire of manipulative actions (month 24) 3) the comparison of the results from the artifact with the data obtained by electrophysiological experiments (month 30).

Expected results are: 1) artificial system able to interact with humans by means of gestures; 2) better understanding of visuomotor representation and learning in humans; 3) new technology for actuation/control/sensing.