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Description of the funded research project

1st Call for H.F.R.I. Research Projects to Support Faculty Members & Researchers and Procure High-Value Research Equipment

Title of the research project: **Assigning Meaning to the Actions of Other Subjects: Neural Correlates**

Principal Investigator: **Helen Savaki**

Reader-friendly title: **AMAOS**

Scientific Area: **Social Sciences**

Institution and Country: **FORTH-IACM, Greece**

Host Institution: **FORTH-IACM**

Collaborating Institution(s): **University of Crete**

Budget: **94.455,00**

Duration: **36 months**

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Research Project Synopsis

We aim to further investigate the neural correlates of assigning meaning to the actions of other subjects.
In accordance with the "Mental Simulation Theory" and in contrast to the "Mirror Neuron Theory" we have demonstrated in human and non-human primates that the execution and observation/recognition of a given action involve the same representational cognitive domain consisting of extensively overlapping sensory-motor neural networks. Indeed, several existing results indicate that binding codes between actual and noetic motor processes is a fundamental modus operandi of the brain.

Here, our objective is to explore which characteristics of the action are critical for its recognition by the observer. A key assumption of the Mirror Neuron Theory is that mirror neurons (known to be activated both for action-execution and action-observation) are responsible for the recognition/understanding of others' actions because they encode the goal rather than the kinematics of the observed actions. In contrast to this notion, recent neurophysiological results indicate that the activity of mirror neurons is correlated with movement kinematics both during action-execution and action-observation.

At present we will use fMRI in humans to study how actions are represented in the entire human brain in general, and in mirror neuron areas in particular. To this end, we will perform double dissociation fMRI experiments in humans, to reveal which components of the brain network activated both for execution and observation of the same action are affected by (i) actions that have the same goals but different kinematics and (ii) actions that have the same kinematics but different goals.

Project originality

If the present project reveals that simulation of the observed kinematic-profile occurs in the observer's brain during mere observation of action, strong evidence will be provided in favor of the mental simulation theory and against the mirror neuron aspect of motor cognition.

Expected results will help dissolve misleading interpretations of (i) psychological phenomena, such as empathy and social behavior, and (ii) developmental disorders such as autism, which are presently based on the mirror neuron theory. Experimental demonstration of the rehearsal of action's kinematics during action observation will open new avenues in education via observational learning and mental training.

The AMAOS project has the potential to influence the fields of cognitive science and neuropsychology by revealing the mechanisms of mental simulation and observational learning. The complementary expertise of the scientists participating in the project promises achievement of its ambitious aim. The area of mental simulation is an area where European scientific thinking leads the rest of the world. Our work in the past has advanced the field. The AMAOS project will strengthen pioneering European research in the cognitive area of mental simulation.

Expected results & Research Project Impact

The neuroscientific importance of our project for cognitive science is that we may demonstrate that the complex mythology around mirror neurons is unwarranted. Expected results will help dissolve potentially misleading interpretations of such complex psychological phenomena as language, empathy, and social behavior based on the mirror neuron theory. Moreover, our results will directly impact on widespread accounts of developmental disorders affecting social cognition such as autism.
Finally, our results will explain why mentally simulated actions (such as observed and imagined actions) bear the same temporal regularities and responsiveness to physical laws as their overt equivalents, and why observational learning and mental training techniques used by professional athletes improve their motor skills.

The societal impact of our project becomes apparent if we consider the fact that more than half of our neuronal processes are dedicated to imaginary life such as planning our actions, predicting its consequences, anticipating others' actions etc., rather than to actual life. The basis of all these imaginary events is the mental simulation principle, which is essential for human cognition and social communication, and which we will study in terms of principles of its neuronal encoding. Understanding mental simulation and learning by observation could help address educational, rehabilitation and social cohesion issues

The importance of this funding

Funding of our project has a major academic impact in training graduate students and junior scientists. The AMAOS project will contribute profoundly in the Multi-Disciplinary Inter-Departmental Graduate Program in "Brain and Mind Sciences" (http://brain-mind.med.uoc.gr/en/node/9), in which members of our team participate actively.

This program is one of the best-structured European programs in the Network of European Neuroscience Schools, offering high quality graduate studies, promoting research in cutting edge scientific and technological fields, and preparing scientists able to excel in academic career, in the public domain, and in the private sector. It contains 3 scientific disciplines: (a) Basic Biological Neuroscience, (b) Computational Neuroscience, and (c) Social and Cognitive Neuroscience.

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