Modeling of Imitation Deficits in Apraxic Patients

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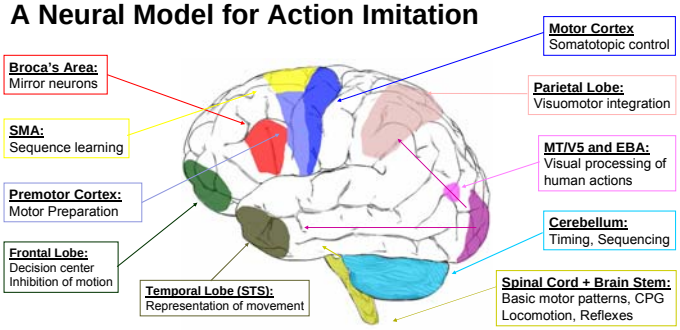
Motivations and Approach

- To understand the basic cognitive and neural mechanisms underlying imitation and learning through observation.
- To develop computer-based and robotic assisted tools for the rehabilitation of brain damaged patients.
- We investigate action imitation through lesion data and conduct behavioral studies to validate our models.

A Neural Model for Action Imitation

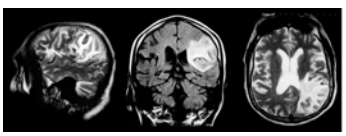


Regions identified as being relevant to the process of action imitation.

Types of Imitation Deficits Considered

Selective impairments of gesture production and imitation following fronto-parietal or callosal brain damages:

- **Apraxia**: the inability to perform voluntary movements [4].
- **Echopraxia**: pathological imitation of movements.
- **Autopagnosia**: deficit in body awareness due to body schema disturbance.



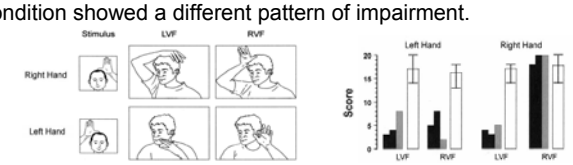
MRI image of an apractic patient with a large left posterior parietal lesion.

Experimental Study

We replicate Goldenberg's seminal study of imitation of meaningless gestures in apraxic patients [1]. We extend the experiment by recording the hand postures and the kinematics of arm motion to provide quantitative data on the variables affected. Motion will be recorded using a set of Xsens motion captors.

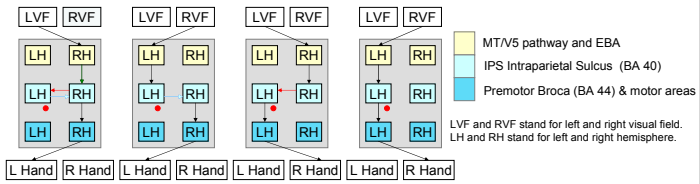
A Functional and Neuroanatomical Model

Goldenberg studied imitation of meaningless gestures in a patient with callosal lesions [1]. The patient was tested in four hand - visual field conditions in two examinations at a seven months interval. Each condition showed a different pattern of impairment.



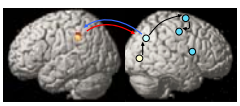
What and where: coding of action imitation

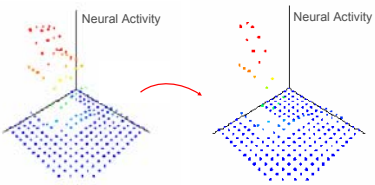
We propose a functional and neuroanatomical model that explains data from [1] and accounts for the information flow through different stages of action imitation (visual recognition, visuomotor integration and execution) across the two hemispheres. In particular, the model suggests a strong solicitation of the left hemisphere at the level of the intraparietal sulcus and is in line with brain imaging studies [2,3].



Computational Model and Numerical Simulations

We conduct simulations to better understand the effects of lesions in the intraparietal sulcus on the dynamics of the information transfer across the two hemispheres.





Neuroanatomical (up) and computational (on the right) models.

Brain areas are represented by somatotopically organized networks (Kohonen algorithm). We use leaky integrate and fire neurons to introduce dynamics into the system.

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References:

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[2] Mühlau M. et al. **Left inferior parietal dominance in gesture imitation: an fMRI study**. *Neuropsychologia*. 43, 1086-1098 (2005).
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[4] Peigneux, P. **L'Apraxie gestuelle. Une approche cognitive, neuropsychologique et par imagerie cérébrale**. *Thèse Doctorat de Psychologie.* Université de Liège. 445p (2000).