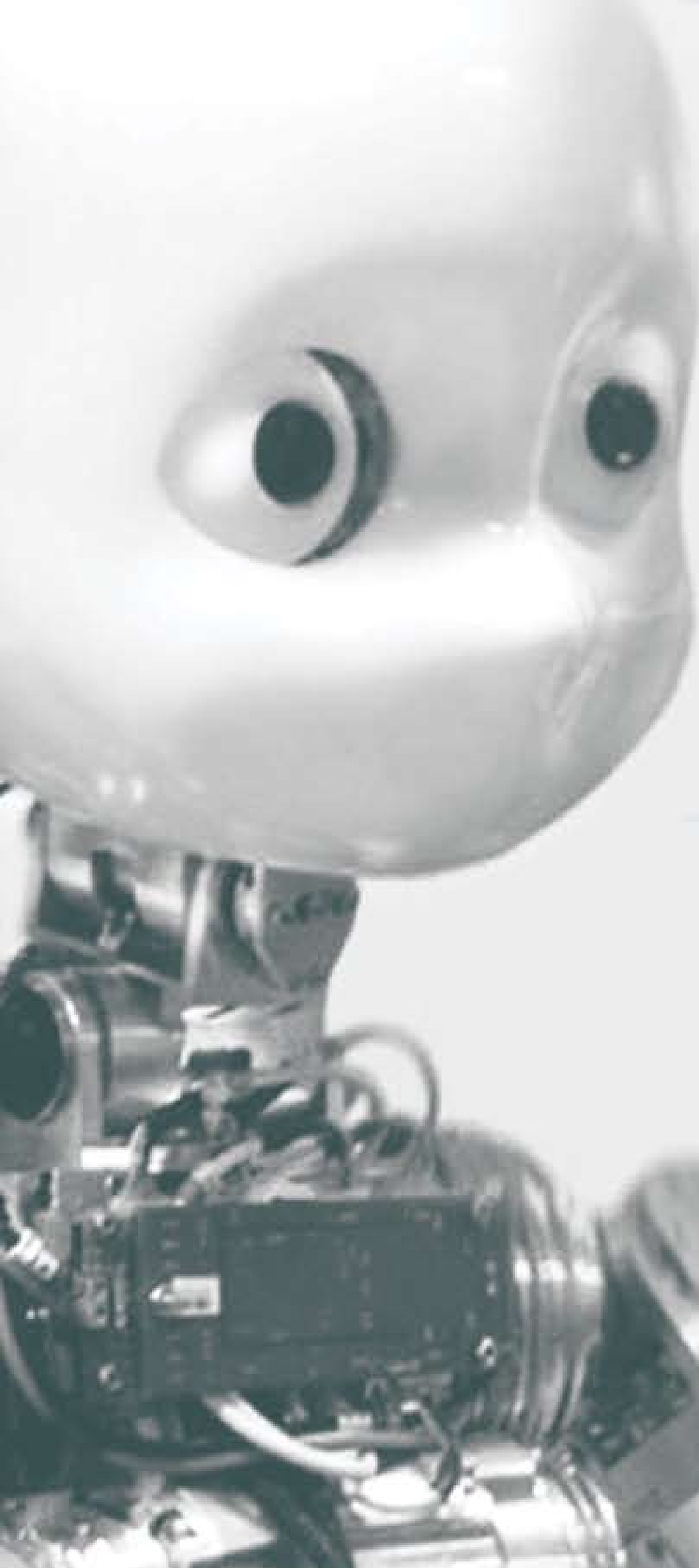
Vision, Action, and Language Unified by Embodiment

A Research Councils UK Cognitive Systems Foresigh Project

value



Summary

The main objectives of this project are: (i) to carry out experimental investigations on microaffordance effects and understand the temporal dynamics of vision, action and language integration; and (ii) to develop a psychologically-plausible model of object manipulation in the iCub robot when it has to select one object from several, grasp the object and use it in an appropriate manner.

Robotic Experiments (Year 1)

The first robotic model replicates the Stimulus-Response Compatibility effect as in Tucker and Ellis (2001). This was developed using the open-source iCub simulator (Tikhanoff et a. 2008).

The robot's vision system consists of two cameras. The simulated robot also has touch and force sensors which receive tactile information and proprioceptive data on its own body posture (16 DoF for one hand and arm). A connectionist network,based on the Jordan recurrent architecture, is used to learn the behaviour of the robot and acquire embodied representations of objects and actions. Visual input is processed using three SOM maps that perform object identity and categorisation tasks as in Caligiore et al.'s (2008).

The robot is first trained on the "microaffordance task", that is to use power grasp for large objects (e.g. apple) and precision grip for small objects (e.g. cherry). Subsequently the robot learns a "categorisation task", that is respond with precision grip to all round object (regardless of size) and with power grasp to cuboid objects.

One important test in this model of object grasping and microaffordances is the comparison of the congruent (where the categorisation grip is in agreement with the natural grip) and incongruent (where there is mismatch between the categorisation grip and the natural grip) conditions. The trained neural networks were presented each object in turn, where the desired target depended on the task being performed. We recorded RMSE values as an analogous to reaction time used in psychological experiments done in the Tucker and Ellis (2001) study. An ANOVA on response times was performed with two factors: congruency and object size, and their interaction was statistically signicant. The results are in agreement with psychological experiments where reaction times are faster in congruent than in incongruent trials. In addition, the reaction times for largerobjects were faster than for smaller object, as was also the case in psychological experiments. This indicates that the robot was able to generalise a grasp ing sequence for each task and object from the four grasping sequences used in training

Psychology and EEG Experiments

Setup of EEG experiment on microaffordance effects

Psychology experiment stimuli with 2 objects having the same left-hand microaffordance

Experimental Results

In parallel to robotics modelling, a variety of experimental investigations have been carried out. The studies in Year 1 of the project include:

EEG Experiments: Event Related Potentials have been recorded for participants performing the stimulus-response compatibility task. These permit the identification of the time course of the activiation of visual and motor areas responsible for microaffordance effects.

Eye-Tracking Experiments. These have permitted the identification of the parts of the visual scene that the participants look at when performing micro-affordance experiments.

Behavioural Experiments. Furtther experiments based on the stimulus-response compatibility effects have been carried out. In particular we have focussed at the use of stimuli with two objects having compatible or incompatible configuration (e.g. two objects with handles pointing respectively at the same or opposite direction). The microaffordance effect was observed for the target object, with faster and more accurate responses made when compatible with the action properties of the target than when incompatible. Performance was also strongly affected by the action properties of the distractor object.

Consortium

University of Plymouth
Angelo Cangelosi
Rob Ellis
Jeremy Goslin
Zoran Macura
Davi Bugmann

University of Dundee
Martin Fischer
Richard Dewhurst
Andriy Myachykov

Advisors
Art Glenberg (Arizona State)
Giorgio Metta, Giulio Sandini (IIT)

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