JAST: Joint Action Science and Technology (FP6-003747)

The Neurocognitive Basis of Joint Action

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Objectives

JAST aims to build jointly acting autonomous systems that communicate and work intelligently on mutual tasks. The project analyses the behaviour and brain function of dyads involved in joint perception, attention, reasoning, planning, action, communication and adaptation. The primary objective is to gain functional insights into these proceses to the extent that it allow us to simulate scenarios involving interacting autonomous agents i.e., human-robot, robot-robot. By extending current neurocognitive analyses of human task performance and dialogue from single to multiple individuals acting together, JAST's research has an impact on fields such as artificial intelligence, cognitive science and brain science.

Topics

In 2005-2007 JAST has, among other topics, conducted research on joint perception and shared attention, and completed studies on computational modelling of joint reasoning. In addition, the project conducted neurocognitive studies of action observation, error monitoring, action preparation and motor coordination in imitative and complementary task contexts. A focused search for brain correlates of joint action has been pursued in several fMRI, MEG and EEG studies, including research on the correlates of emerging dialogue strategies in a Tacit Communication Game paradigm. An elaborate analysis of human gaze, dialogue and cooperative task performance exploiting a specially-developed dual-gaze paradigm has yielded insights that afford the design of an intelligent autonomous dialogue manager. JAST combines cognitive AI, Bayesian and dynamic force-field approaches. As such it bridges paradigms that traditionally have focused on either discrete-symbolic representations or on continuous-subsymbolic processes.

Examples

A typical example of JAST's research by De Bruijn et al. [1] involves a cooperative speeded choice reaction time task to study the relationship between adaptive behaviors following own and observed errors. The results show that observing another's error activates the same neural correlates and has the same consequence for one's own behavior as detecting an error in oneself. People react to an observed error as if it was their own, supporting the conclusion that the functional systems responsible for initiating adaptive behaviors are the same for own and observed errors. These systems can be engaged in cooperative social situations providing a basis for observational learning. Another example of JAST's research addresses Bayesian statistics, which has been very successful in explaining behavioural data on decision making, cue integration, in particular under conditions of uncertainty. In the model of goal inference and joint reasoning developed in JAST by Cuijpers et al. [2] Bayesian statistics were used to model decision-making in joint action. Although functionally adequate such a model shows little relation to actual processes in the brain. On the other hand, the biologically inspired neural field approach as adopted in JAST is much closer to actual processes in the brain. However, how neural fields can incorporate Bayesian statistics is still an open issue. In a recent study, Cuijpers demonstrates the way in which two fundamental statistical laws (Bayes rule and marginalisation of conditional probability distributions) can be implemented using neural fields. The study thus shows how discrete and continuous neurocognitive processes can be simultaneously accounted for.

[1] De Bruijn, E.R.A., Miedl, S. F., Bekkering, H. (in press). Fast responders have blinders on: ERP correlates of response inhibition in competition. *Cortex*.

[2] Cuijpers R.H., Van Schie H.T., Koppen M., Erlhagen W. and Bekkering H. (2006). Goals and means in action observation: a computational approach. *Neural Networks, 19,* 311-322.