

# Final Report

## Research Group

### Embodied Communication in Humans and Machines

October 1, 2005 – September 17, 2006

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Traditionally, communication research has focused on the exchange of verbal information using the engineering model of signal transmission as the main theoretical metaphor. That is, it was assumed that a sender A produces and sends a signal to a receiver B that interprets the signal as a message, and vice versa (see Fig. 1). Recently, there has been growing evidence that human communication is more than exchanging verbal messages; there appears to be a close coupling between partners interacting face to face (Fig. 2). Gesture, mimics, posture, and rhythm among others are crucial to this coupling. That is, human communication ought to be studied as embodied communication, taken to entail any exchange of information among social partners by way of multiple input and output channels that decisively depend on the presence of their expressive bodies.

Accordingly, the goal of the ZiF research year on Embodied Communication was to develop an integrated perspective of embodied communication from a vast body of research findings to decisively enhance our understanding of how living beings produce, perceive, and understand especially bodily gestures. As a part of this enterprise it was asked how such gestures are used to effectively coordinate actions and the levels of explanation applied to this problem ranged from theories that explain the functioning of single neurons to theories addressing complex social interaction.



--- Fig. 1 ---



--- Fig. 2 ---

With these ideas in mind it was possible to recruit 24 fellows and 8 associated members (15 fellows and 5 associated members had an affiliation to international institutions). During the preparatory conference in January 2006 the prospective fellows coordinated their times of residence at ZiF and outlined a raw sketch of the topics to work on. It turned out that for most of the researchers it is difficult or even impossible to get away from their home universities for a whole or even half a year. As a consequence, the majority of fellows joined the group for three, four, or five months. This fluctuation was an organizational challenge, but it also structured and enriched the research year considerably. The associated members enriched the residential fellows' group with shorter stays, remaining in the network through the

group's internet environment. At times, external scientists were invited to give seminars to the research group.

The fellows came from fields as diverse as cognitive science, linguistics, human ethology, psychology, robotics and computer science, philosophy and biology. This indicates that the research topic is truly of interdisciplinary interest and introduced a variety of methodologies into the group's work. Special emphasis was laid on the simulation of aspects of communication in virtual agents. This is a very instructive way to test theories that seem plausible from the armchair perspective but often suffer from hidden problems when it comes to details.

Everyday work was structured by holding two meetings per week. As expected, the interdisciplinary work was not always easy. However, fed by daily coffee and cookie meetings in the ZiF, agreements sometimes emerged out of heated interdisciplinary debates. The discussions provided ample proof that communication is a highly social, dynamic and interactive process. Occasion for "cooling down" and socializing was given not only by casual barbecues on the ZiF campus, but also by a number of trips to sights in the environment, such as the Externsteine, the Hermannsdenkmal, the Open Air Museum Detmold, and the Martha Museum in Herford. An invitation by the research group's fellow Josep Call took the group to Leipzig Zoo where Call explained his research on the social cognition of primates.

The work of the research group was framed by two larger conferences at the beginning and at the end of the research year and three thematic workshops in between, focusing on evolution, robots, and social interaction. A post-workshop to the latter focused on the 'forward-looking nature' of communication. For these events the group invited further external experts to discuss intermediate results that had been obtained and to further enrich the resident fellows' perspectives.

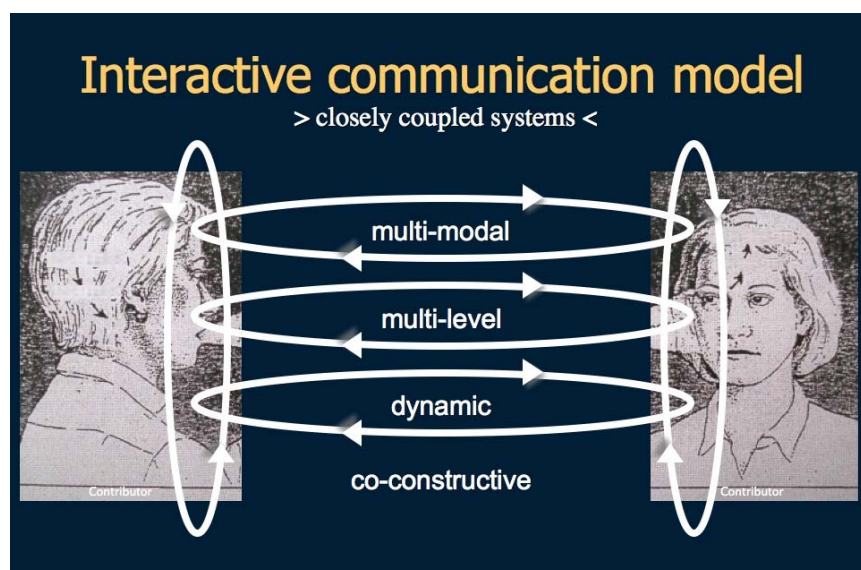
In the starting phase of the research year the fellows presented their own results with special focus on its relevance for embodied communication. Whenever new fellows joined the group they were asked to introduce their work – sometimes even before they had had the chance to overcome their jetlag. After warming up, the research group focused on the evolution and ontogenesis of human communication abilities, identifying constraints for an embodied communication perspective that could be derived from primatology and developmental psychology.

In the later phases of the research year the talks and discussions revolved around social understanding, the human body, and the analysis of bodily movements. In the summer meetings – sometimes held as "open air lectures" – the research group started, and often rewrote a "Mindmap", a sketch to sort and integrate the many aspects emerging from the discussions. Hot topics were the motor theory of representation, the role of the mirror system in communication, turn-taking, facial displays, feedback, rhythm in speech and gesture, and how to model these aspects in an artificial agent. The group also looked at the evolutionary roots of communicative abilities and at disorders like apraxia and aphasia, which provide further information about the neuro-cognitive mechanisms underlying normal unimpaired communication.

Some of these topics were taken up by subgroups that met in addition to the two weekly group meetings. For instance one group focused on the role of feedback signals in face-to-face communication and came up with their first publication-ready paper after three months into the research year. Another group, which still continues to collaborate between Bielefeld and Chicago, attempted to implement psycholinguist David McNeill's Growth-point Theory of language and gesture production in the virtual agent Max developed at Bielefeld University's Artificial Intelligence Lab.

Taken together, the research group's work resulted in launching and exploring an integrated and interdisciplinary perspective on communication that accounts for the crucial role of the body. It creates a novel framework for interpreting and integrating recent empirical findings in the cognitive and neurosciences, and for studying and advancing human-machine communication with embodied agents such as robots and virtual humans.

The core claim of the "Embodied Communication Perspective" can be described as follows. When communicating face-to-face, people enter into a close and interactive social loop, in which they influence each other (consciously and unconsciously) not only by what is being said. Rather it appears that they become closely coupled by their body motion, their gestural rhythm, their facial expressions, speech intonation, and by a complex interplay of these factors. In this dynamic process, basic mechanisms like mirroring, gaze following, joint attention, simultaneous posture shifts and the unconscious uptake of the other's communicative rhythm, as well as giving and reacting to feedback signals, are of primary importance. On a higher, consciously experienced level these concerted mechanisms bring about mutual understanding and support joint action and "mind reading".



--- Fig. 3 ---

Going beyond the traditional engineering model of signal transmission, the Embodied Communication Perspective hence envisions a multi-modal, multi-level, dynamic, co-constructive model of communication (Fig. 3). Rather than "exchanging meaning" in back-and-forth messaging, the contributors are co-constructing meaning interactively using all information available about the other's body and its relation to the environment.

The details of the Embodied Communication Perspective and its implications for the study and advancement of human-machine communication will be elaborated on in publications and other media. Besides a number of articles in scientific journals and science magazines, such as *Scientific American Mind*, the ongoing work of the research group was frequently featured in newspaper articles as well as in radio and TV. A comprehensive account of the scientific results of the research year will be documented in two edited volumes, which are currently in preparation.

Ipke Wachsmuth, Manuela Lenzen, Günther Knoblich (eds): *Embodied Communication in Humans and Machines*, Oxford University Press

Ipke Wachsmuth, Günther Knoblich (eds): *Modeling Communication with Robots and Virtual Humans*, Springer Verlag

#### Events:

January 12–15 2005: Preparatory Conference: Embodied Communication: A Research Agenda

October 5–8, 2005: Opening Conference: Embodied Communication I

January 11–14, 2006: Workshop: The Phylo- and Ontogenesis of Understanding and Communication

April 5–8, 2006: Workshop: Modeling Communication with Robots and Virtual Humans

July 5–8, 2006: Workshop: Embodied Communication, Joint Action, Social Understanding

July 10-11, 2006: Post-Workshop: The Forward-Looking Nature of Embodied Communication: Projection, Participation, and Time-Scales in Social Interaction

September 6–9, 2006: Final Conference: Embodied Communication II: An Integrated Perspective

A first follow-up event, a conference, to take place at the ZiF in June 2008, has already been approved by the ZiF's Board of Directors: "The Enculturated Body: Scales of Embodied Meaning in Communication" (Jordan/Streeck/Wachsmuth)