3rd Joint Action Meeting

July 27-29, 2009

Het Trippenhuis
Tinbergenzaal
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Organized by:
Cordula Vesper, Günther Knoblich and Natalie Sebanz

Radboud University Nijmegen, NL

Program

	Monday	Tuesday	Wednesday	
8:45	Welcome			
9:00	Talk session A *Dynamics of joint action*	Talk session E *Joint action and joint perception*	Talk session I *Joint action coordination*	9:00
10:30	Poster session 1 / Coffee break	Poster session 2 / Coffee break	Coffee break	10:30
11:00			Talk session J *Joint action (hi)stories*	11:00
11:30	Talk session B *Joint action and joint thought*	Talk session F *Crosstalk between bodies*		
12:30			Final discussion	12:30
1:00	Lunch	Lunch	End	1:00
2:00	Talk session C *Perception action links*	Talk session G *Interpersonal synchronization*		
3:30	Demo / Poster session 1 / Coffee break	Demo / Poster session 2 / Coffee break		
4:30	Talk session D *Understanding joint activity*	Talk session H *Task sharing*		
6:00	End	End		

Talk sessions

Talk session A: *Dynamics of joint action*

Richard C. Schmidt
Dynamics of activity in structured conversation

Emmanuelle Tognoli, Daniela Benites, Gonzalo C. De Guzman and J. A. Scott Kelso
Neural mechanisms of social coordination: Continuous EEG analysis using a novel 4d colorimetric method

J. Scott Jordan
The forward-looking nature of perception-action coupling as a basis for joint action

Talk session B: *Joint action and joint thought*

Cyprian Laskowski and Martin Pickering
The role of language in conceptual coordination

Antonella Carassa and Marco Colombetti
Achieving joint meaning of communicative acts

Elisabeth Pacherie
Beyond small-scale, egalitarian actions: coordination tools and normative thinking

Talk session C: *Perception action links*

Matthew Ray and Tim Welsh
The immediate and short term effects of action observation on the motor system

Hein van Schie
Levels of action representation in the human mirror neuron system

Wolfram Erlhagen and Estela Bicho
What can we learn from the mechanisms underlying human joint action for more natural human-robot interaction?

Talk session D: *Understanding joint activity*

Maria Gräfenhain, Malinda Carpenter, Tanya Behne and Michael Tomasello
Young children's understanding of joint activity in social play contexts

Henrike Moll, Malinda Carpenter and Michael Tomasello
Social engagement leads 2-year-olds to over-attribute knowledge to others

Stephen Butterfill
Sharing goals vs. sharing intentions: When are shared intentions necessary?

Talk session E: *Joint action and joint perception*

Luisa Sartori, Cristina Becchio, Maria Bulgheroni and Umberto Castiello
The influence of social intentions on the on-line control of action

Stephan de la Rosa and Astros Chatziastros
What is the speed of perceptual processes underlying joint-action recognition?

Daniel C. Richardson, Merrit Hoover and Arezou Ghane
Joint perception

Talk session F: *Crosstalk between bodies*

Sanjay Chandrasekharan and Timothy Welsh
Current body-state influences action possibility judgments

Michael J. Richardson
Dynamics of interpersonal movement interference: Effects of intention, attention, and agency

Verónica C. Ramenzoni, Michael A. Riley and Kevin Shockley
Interpersonal coordinative structures in a joint-precision task

Talk session G: *Interpersonal synchronization*

Ivana Konvalinka, Peter Vuust, Dimitris Xygalatas, Andreas Roepstorff and Chris D. Frith
Synchronization in joint action: From tapping to fire-walking

Michael J. Hove and Jane L. Risen
The In-sync effect: Interpersonal synchrony increases affiliation

Lynden K. Miles, Joanne Lumsden, Michael J. Richardson and C. Neil Macrae
Social group membership and interpersonal synchrony

Talk session H: *Task sharing*

Antje Holländer and Wolfgang Prinz
The underlying mechanisms of task sharing

Andrea M. Philipp and Wolfgang Prinz
An agent-based joint compatibility effect

Jessica Tsai
I don't mind how you do it: Acting together with real persons versus animated hands

Talk session I: *Joint action coordination*

Cordula Vesper
Coordination strategies in joint action tasks with timing constraints

Jurjen Bosga and Ruud G.J. Meulenbroek
Managing redundancy at multiple levels of motor control

Caroline Palmer and Werner Goebl
Interpersonal coordination among performing musicians

Talk session J: *Joint action (hi)stories*

Klaus Kessler
Spatial perspective taking might have been shaped by the constraints of joint actions like learning by imitation

Michael Spranger
Can joint action facilitate visuo-motor coordination?

Rene Selich (formerly Sebanz and Knoblich)
The feel of joint action

Poster sessions

Demo (parallel to poster sessions 1 & 2)

Hanne De Jaegher
Would you like to participate?

Poster session 1

Afshin Aheadi and Scott Glover
Strategic and online control in joint action

Karen Bartling, Franziska Kopp and Ulman Lindenberger
Infants' sensitivity to interpersonal timing

Daniela Benites, Emmanuelle Tognoli, Gonzalo C. De Guzman and J. A. Scott Kelso
The complementary nature of joint ~ individual action: neural correlates of uncoordinated action and self-behavior

Antonella Carassa, Marco Colombetti and Viola Schiaffonati
Joint activities: A deontic approach

Miriam de Boer, Roel M. Willems, Matthijs L. Noordzij, Jan Peter A. de Ruiter, Peter Hagoort, Ivan Toni
The neural basis of communicative and linguistic abilities and the influence of inter-subject differences (on their communicative quality)

Natalie Sebanz, Terry Eskenazi, Adam Doerrfeld and Guenther Knoblich
I will remember you: Enhanced memory for information pertaining to a relevant other

Poster session 1 (contd.)

Christine Fawcett and Ulf Liszkowski
Infants imitate joint action

Katharina Hamann, Felix Warneken and Michael Tomasello
Peers' mutual support when pursuing shared goals

Idil Kokal, Valeria Gazzola and Christian Keysers
Acting together in and beyond the mirror neuron system

Dimitrios Kourtis, Natalie Sebanz and Günther Knoblich
Predictive action simulation depends on the task-induced social relation between actor and observer

Ulf Liszkowski
Joint acting and joint pointing at 12 months

Marlene Meyer, Sabine Hunnius, Markus Paulus and Harold Bekkering
The development of temporal coordination in joint and single actions during early childhood

Amir Sadeghipour and Stefan Kopp
Gesture learning through imitation during social interactions

Yvonne Steggemann, Stefan Kopp and Matthias Weigelt
Adaptive embodied communication: Teaching sequences of actions by real and virtual humans

Jasmin Steinwender, Felix Warneken and Michael Tomasello
Collaborative problem solving and spontaneous role reversal in 2- and 3-year-old peers

Poster session 2

Anne Böckler, Natalie Sebanz and Günther Knoblich
The effect of joint attention on object processing

S. Endo, P. Evrard, A. Kehdder, R. M. Bracewell and Alan Wing
An adaptive behavioural change in cooperative object lifting

Terry Eskenazi, Pia Rothstein, Marc Grosjean and Guenther Knoblich
How difficult can it be? Fitts's law in action perception: an fMRI study

Paula A. Fitzpatrick and Richard C. Schmidt
A preliminary investigation of the dynamics of interpersonal hand-clapping games

Caroline Gillett, Carl Jackson and Chris Miall
Learning joint control of a cursor in a shared task space

Debra Griffiths and Steven P. Tipper
Observing others reaching in our action space primes our own hand-path trajectories

Christina Jäger, Antje Holländer and Wolfgang Prinz
Interpersonal coordination and interference: Synchronization and task sharing in a shared bimanual reaching paradigm

Birgit Knudsen
Do co-actors share tasks or actions? Evidence from a double response paradigm

Poster session 2 (contd.)

Janeen Loehr, Rowena Pillay and Caroline Palmer
Action representations in joint music performance

Laura McDougall and Tim Welsh
Auditory response effects do not activate between-person inhibition of return

Louise K. Nind, Lynden K. Miles and C. Neil Macrae
The rhythm of rapport: Interpersonal synchrony and social perception

Sukhvinder S. Obhi, Kristin House and Lars Strother
Agency, intentional binding and co-intention

Stephanie Paulson, Laura McDougall and Tim Welsh
The influence of the observer's posture on body-form compatibility effects

Stephan Streuber
Assessing visual information in a collaborative table tennis task

Robrecht van der Wel
Corepresentation of others' action alternatives: Does Hick-Hyman law hold for self and other?

Michael Villiger, Sanjay Chandrasekharan and Tim Welsh
Neurophysiological modulation of human motor cortex during the observation of grasping movements: A transcranial magnetic stimulation study

Abstracts

(in alphabetical order)

Strategic and online control in joint action

1

Afshin Aheadi and Scott Glover

Royal Holloway University of London, UK

Previous work on joint action has focussed on how cooperating pairs represent each others' actions at a strategic level. This work expands on this in two ways: First, by examining the kinematics of joint action; second, by examining the effects of inducing an artificial perturbation in one participant. The first experiment had pairs cooperate in a task involving passing an object between them and then placing it down in a target area. on some trials the object had to be rotated prior to placement. We observed that the person who initiated the movement (P1) would rotate the object prior to passing it to the person who finished the movement (P2). Subsequent experiments expanded on this by introducing a mechanical perturbation of P1 at movement onset. In these studies, we observed not only a change in the strategy employed by both participants,but also a number of online adjustments in P2 to the lack of coordination caused in P1 by the perturbation. Taken in sum, this work shows that joint action operates not only at a strategic level, but also at a more basic motoric (online) level.

Infants' sensitivity to interpersonal timing

1

Karen Bartling, Franziska Kopp and Ulman Lindenberger

Max Planck Institute for Human Development, DE

In social interactions, rhythms aid interpersonal coordination by providing cues for predicting the behavior of the interaction partner. Especially early in life, when the dyadic interaction between mother and infant is mainly nonverbal, much of the affective communication is carried in the temporal properties of the interaction. As rhythmic patterns seem to facilitate information processing and interpersonal timing prediction, they provide the infant with a structure for shaping temporal expectancies that organize social as well as cognitive experience. Hence, a key component of the early exchange between mother and child is the contingency of the maternal response.

The goal of the present study was to disentangle the development of infants' sensitivity to contingency in general and interpersonal timing per se using behavioral as well as (neuro-) physiological measures. In a live interaction paradigm, five- and seven-month-old infants and their mothers interacted via two screens. Maternal response to the infant's signals was manipulated by the degree of contingency (live, delay, replay). Results indicate that already by the age of five months, infants are sensitive for interpersonal timing next to social contingency. While in seven-month-old infants this finding is supported by behavioral and physiological data (ECG), in the younger infants only heart rate data indicate their sensitivity for interpersonal timing. The influence of the degree of maternal affect attunement on the development of infant's sensitivity to interpersonal timing is discussed.

The complementary nature of joint ~ individual action: neural correlates of uncoordinated action and self-behavior

1

Daniela Benites, Emmanuelle Tognoli, Gonzalo C. De Guzman and J. A. Scott Kelso

Florida Atlantic University, USA

In the framework of coordination dynamics, opponent pairs of concepts (e.g. self and other) may be formally viewed as complementary forces of a dynamical system (Kelso & Engstrom, 2007). These forces create rich behavior during which tendencies for integration and segregation co-exist. Integration of self- and other-behavior leads to cooperative action and togetherness; their segregation leads to loss of coordination and apartness. Whereas integration alone yields a restricted range of social behavior, the dynamics of integration-segregation (togetherness ~ apartness) allows for complex social behavior to arise. Accordingly, a complete understanding of joint action requires studying both coordinated and uncoordinated behavior, as well as their respective transitions. We recorded the EEG of pairs of people engaged in a task of intentional social coordination. We identified spatio-temporal patterns in continuous brain dynamics that were associated with loss of coordination. Results are discussed in relation to the concept of self, as an experience that emerges continuously in time (Hermans & Van Loon, 1992; Wiley, 1995). Besides its significance for understanding joint action, this study may shed light on the origin of the sense of identity, and further on conditions in which a predominant self-process brings about pathology (e.g. depression, schizophrenia, autism).

The effect of joint attention on object processing 2

Anne Böckler, Natalie Sebanz and Günther Knoblich

Radboud University Nijmegen, NL

The ability to follow other individuals' gaze has been widely demonstrated in young infants as well as in primates, birds, and other animals (Meltzoff & Brooks, 2007; Itakura et al., 2004). But what are the cognitive consequences of jointly attending to objects? Recent findings suggest that humans unintentionally adopt the emotional evaluation of another person attending to one and the same object (Bayliss et al., 2006) and that stimuli that used to be relevant for another, co-attending individual tend to be remembered better (Sebanz et al.). The aim of the present experiments was to investigate the effect of jointly attending to objects on the perceptual processing of those objects. For this purpose, pairs of participants were seated opposite each other while performing a mental rotation task. Tones presented ahead of rotation stimuli indicated whether both participants were to look at the screen (joint attention) or whether one of them had to perform the trial alone while the other closed the eyes (individual attention). Anchor stimuli of the sequential rotation task could either be seen from a first or from a third person perspective. Although further research is needed to draw clear-cut conclusions, results indicate that joint attention modulates the classical rotation pattern as well as the effect of perspective.

Managing redundancy at multiple levels of motor control

Jurjen Bosga[1] and Ruud G.J. Meulenbroek[2]

[1]Praktijk Bosga-Stork, NL; [2]Radboud University Nijmegen, NL

In two studies we address an important research topic in cognitive neuroscience, i.e. how we manage the excess of resources in our motor system that allows us to perform a movement task in different ways.

In both studies we exploited a rocking board task to investigate intraindividual and interindividual control when people are mechanically coupled. In one study we address the key role the visual modality is assumed to play in interindividual movement coordination and the way dyads control the combined amplitude/frequency constraints of the task. The results demonstrated that exploitation of biomechanics in goal-directed task performance is a prominent motor control mechanism that seems to operate independently of the modalities people use to monitor the perceptual consequences of the generated motion patterns.

In the other study we tested the generality of the Leading Joint Hypothesis (LJH) in a kinematic analysis of the joint-coordination patterns that dyads display when they need to manipulate a rocking board along a prescribed angle and at an imposed frequency. We found knee rotations to create a dynamic foundation at both intra- and interindividual levels involving subordination of individual action to joint performance to allow for low-dimensional control of joint action in this high-dimensional, repetitive motor task.

The studies show that we are very clever in exploiting the biophysical properties of our motor system and can deliberately override biomechanical efficiency for goal attainment. Furthermore, the studies demonstrated that control principles that have been postulated for individual motor control are also applicable to joint action.

Sharing goals vs. sharing intentions: When are shared intentions necessary?

D

Stephen Butterfill

University of Warwick, UK

According to a leading philosophical account, joint action requires shared intentions, and shared intentions involve intentions about the subplans of others' intentions (Bratman 1993). On this account, joint action requires sophisticated theory of mind cognition and is cognitively demanding. But Joint action appears to emerge earlier in human development than the requisite understanding of intentions and subplans. Joint action also does not appear to be cognitively demanding; indeed, in some cases effort may be required to inhibit acting jointly. So the philosophical account conflicts with empirical research.

This talk aims to resolve the conflict in two steps. Step one is to identify a kind of joint action based on shared goals rather than shared intentions. Roughly, several agents share a goal when: (a) their individual goals all involve a single outcome; and (b) each expects this outcome to be a common effect of all their actions. Although conceptually unsophisticated and cognitively undemanding, I argue that many cases of joint action from cognitive and developmental research can be characterised at least as well by shared goals as by shared intentions. This is also consistent with claims that joint action is important in human development and communication by language.

The second step is to distinguish cases where shared intentions, rather than only shared goals, are necessary. The key to this distinction is how coordination of action is achieved. With joint action based on shared goals only, coordination depends on low-level, automatic mechanisms. By contrast, where intentions are shared, agents are disposed to reason explicitly about the meshing of their subplans.

Achieving joint meaning of communicative acts

B

Antonella Carassa[1] and Marco Colombetti[1,2]

[1]University of Lugano, CH; [2]Politecnico di Milano, I

The problem Is a communicative act an individual action, as treated in classical Speech Act Theory, or a participatory action, as argued for example by Herbert Clark (1996)? The key difference between the two positions lies in the conception of uptake: while Speech Act Theory regards uptake as the hearer's comprehension of the speaker's communicative intention (Strawson, 1964), Clark views uptake as the hearer's acceptance of a joint project involving the speaker and the hearer. In so doing, however, Clark conflates aspects that concern meaning with aspects that pertain to perlocution.

Our proposal We propose to understand the participatory nature of communicative acts though a different view of uptake, which we call deontic uptake, whose function is to turn individual speaker's meaning into genuine joint meaning of the speaker and the hearer. In our view (Carassa & Colombetti, to appear):

(i) a communicative act is an individual action that generates deontic affordances, which can be exploited by the hearer;

(ii) a type of deontic affordance produced by a communicative act is the possibility for the speaker and the hearer to jointly commit (Gilbert 1996, 2000) to the fact that the communicative act has been performed; such a joint commitment, that we call joint meaning, is achieved through the hearer's deontic uptake;

(iii) a further type of deontic affordance is the possibility for the hearer to participate with the speaker in a joint project that goes beyond the pure production of meaning; however, joint meaning can be achieved even if the joint project is rejected by the hearer.

Carassa, A., and Colombetti, M. (to appear). Joint meaning. Conditionally accepted for publication on the Journal of Pragmatics.

Clark, H. H. (1996). Using language, Cambridge University Press, Cambridge.

Gilbert, M. (1996). Living together: Rationality, sociality, and obligation. Rowman & Littlefield, Lanham (MD).

Gilbert, M. (2000). Sociality and responsibility: New essays in plural subjet theory. Rowman & Littlefield, Lanham (MD).

Strawson, P. F. (1964). Intention and convention in speech acts. The Philosophical Review 73 (4), 439–460.

Joint activities: A deontic approach

1

Antonella Carassa[1], Marco Colombetti[1,2] and Viola Schiaffonati[1,2]

[1]University of Lugano, CH; [2]Politecnico di Milano, I

How individuals come together spontaneously is a fundamental issue in understanding joint activities. According to Michael Bratman (1987), personal intentions are sufficient to orient conducts and stabilize actions at an individual level, at both planning and execution time. Does anything play an analogous role in joint actions? Following Margaret Gilbert (1996), we believe that joint commitments are at the basis of collective intentionality and function to stabilize joint actions.

Joint commitments are desire-independent reasons for actions that can be better understood within a situated perspective. First of all, joint commitments arise from the activities carried out by agents in concrete situations and are not necessarily the result of explicit agreements. Moreover, what agents jointly commit to is often not a predefined course of action, but a group attitude (like for example a group belief), which may motivate actions of different types in different situations.

In this talk we concentrate on the creation of a joint commitment, interpreted as the collective analogue of the construction of an action plan in the case of individual actions. We suggest that agents typically enrich the current situation by creating new deontic affordances, that is, new possibilities for other agents to build desire-independent reasons for action that are shared by all members of a group. We argue that understanding how such deontic affordances are created, accepted, negotiated or rejected in concrete situations is going to be an important step toward a satisfactory analysis of joint action.

Bratman, Michael, E., 1987. Intention, Plans, and Practical Reason, Harvard University Press, Cambridge (MA).
Gilbert, Margaret, 1996. Living together: Rationality, Sociality, and Obligation, Rowman & Littlefield, Lanham (MD).

Current body-state influences action possibility judgments

F

Sanjay Chandrasekharan and Timothy Welsh

University of Calgary, CA

To plan and execute joint actions, one must be able to judge what is and what is not possible for their partner to perform. It has been suggested that these judgments are formed, in part, through the simulation of the to-be-performed task of the other person. It has been further suggested that these simulations are based on the action capabilities of the simulating individual. Supporting this simulation account, we found that executing the judged action improves the accuracy of action judgments (Chandrasekharan et al., submitted). As such, we have been interested in the simulation process and factors that affect simulation. One factor might be current body state because research on embodied cognition has revealed that current body state can affect other perceptual judgments. Thus, the present work was conducted to determine if current body state influences action possibility judgments. Participants watched a hand moving at different speeds between two targets. The targets varied in size and in the distance between them according to the index of difficulty described by Fitts' Law. Participants were asked to judge if it was possible to move accurately at the witnessed speed under two conditions: with or without a weight on their wrists. Consistent with previous research, a significant difference was observed between the weight conditions - movements seen during the weighted condition were judged as possible at slower speeds than the same movements in the unweighted condition. These results suggest that current body state may affect simulation and the judgment of action possibility.

The neural basis of communicative and linguistic abilities and the influence of inter-subject differences (on their communicative quality)

1

Miriam de Boer[1], Roel M. Willems[1], Matthijs L. Noordzij[2], Jan Peter A. de Ruiter[3,4], Peter Hagoort[1,4] and Ivan Toni[1]

[1]Radboud University Nijmegen, NL; [2]University of Twente, NL; [3]Bielefeld University, DE; [4]Max Planck Institute for Psycholinguistics, NL

Although language is a very effective vehicle for communication, it is unclear how our linguistic and communicative abilities relate to each other. Some have argued that communicative message generation involves taking the perspective of the addressee ("mentalizing"), and - crucially - that mentalizing depends on language. Here we employed a verbal communication paradigm to directly test A) whether the generation of a communicative action relies on mentalizing and B) whether the cerebral bases of communicative message generation are distinct from those sensitive to linguistic variables. Our results show that dorso-medial prefrontal cortex, a brain area previously associated with mentalizing abilities, was sensitive to the communicative intent of the utterances, irrespective of linguistic difficulty. On the contrary, left inferior frontal cortex, an area known to be involved in language, was sensitive to the linguistic demands of the utterances, but indifferent to communicative intent. These findings support the notion that our communicative and linguistic abilities rely on cerebrally (and computationally) distinct mechanisms

Would you like to participate?

1 & 2

Hanne De Jaegher

Ruprecht-Karls Universität Heidelberg, DE; University of Sussex, UK

In this activity, you will be invited to explore what it is like to participate in each other's understanding of the world, in a simple drawing exercise designed to let people experience joint action. After the exercise, we will examine the experience together with the help of a set of concepts that serve to understand social understanding from an interactive perspective.

One of the non-intuitive postulates of the participatory sense-making* approach to social understanding is that the interaction process itself can take on a life of its own. One implication of this idea is that the interaction process as such can influence the interactors, over and above the influence that each participant exerts on the other. A simple, everyday example is when you encounter someone walking in the opposite direction in a narrow corridor. All you want to do is walk past the other and continue on your way. But it can happen that, without either of you wanting to, you enter an interactional coordination in which you both keep on mirroring each other. You step from one side to the other a couple of times and so does the other, and you remain in each other's way. In such a situation, the interaction process takes on an autonomy and overrides your individual intentions. We describe this example in more theoretical and technical detail in De Jaegher and Di Paolo (2007).

In this workshop activity, I introduce participatory sense-making, an approach to intersubjectivity in which intentions are conceived as dynamic (not static), overt (not internal and hidden), emerging and transforming in and through interaction, in a hands-on exercise followed by a short theoretical exploration.

De Jaegher, H. and E. Di Paolo (2007). "Participatory Sense-Making: An enactive approach to social cognition." Phenomenology and the Cognitive Sciences **6**(4): 485-507.

What Is the speed of perceptual processes underlying joint-action recognition?

E

Stephan de la Rosa and Astros Chatziastros

Max Planck Institute for Biological Cybernetics, DE

Joint-actions are an integral part of everyday human life. It is often critical in everyday situations that joint-actions are recognized quickly as when one is driving on a road and has to recognize children playing with a ball on a sidewalk to detect a possible danger. Surprisingly relatively little is known about the speed of joint-action recognition. Here we investigated how fast joint-actions can be recognized on three levels of detail (detection, categorization, and identification). We assessed the speed of joint-action recognition by comparing the speed of joint-action recognition with object recognition, which is known to be fast (e.g. Thorpe et al., 1996). In a series of experiments we presented static images of objects and joint-actions at varying presentation times to participants and measured their detection, categorization, and identification performance. We find that presentation times of less than 80 ms allowed joint-action recognition to be highly accurate (79%) in all three recognition tasks. Interestingly for some joint-actions we found identification to be as fast as object identification. Overall it seems that the speed of detecting and identifying joint-actions and objects are comparable. This poses a challenge to the notion that humans employ time consuming inferential processes in the recognition of joint-action ("theory of mind"). Moreover we find that the speed of joint-action and object categorization differ significantly suggesting that objects and joint-actions are processed early on by different perceptual processes.

An adaptive behavioural change in cooperative object lifting

2

S. Endo, P. Evrard, A. Kehdder, R. M. Bracewell and Alan Wing

University of Birmingham, UK

One important aspect of human action is that the CNS adaptively corrects movement errors that are generated either by an internal or external origin. In cooperative action in which a dyad attempts to achieve a shared goal, the source of an error, largely due to the incompatible movement plans between the partners, can be delegated to each of them, and it can be corrected by either of them. This study reports the adaptive behaviour of dyads in a cooperative object lifting task wherein the participants adaptively modulated the degree to which they corrected the movement errors (i.e. correction gain), based on that introduced by a task partner.

During the task, a human participant synchronously lifted an object with a task partner so the object orientation remained horizontal. To systematically study the human behaviour, we employed a humanoid robot as a task partner which modified its movement parameter (i.e. peak velocity of lifting motion) across trials to reduce the difference from the human partner by a predefined correction gain. The analyses on the correction gain of the human partner showed a clear evidence of flexibly modulating the gain to match that implemented in the robot so that the gain remained optimal as a dyad. In conclusion, the study suggests that humans can incorporate behavioural characteristics of a task partner to optimise the outcome of a shared goal as a dyad in a cooperative task.

What can we learn from the mechanisms underlying human joint action for more natural human-robot interaction?

C

Wolfram Erlhagen and Estela Bicho

University of Minho, P

As robot systems are moving as assistants into human everyday life, the question how to design robots capable of acting as sociable partners in collaborative joint activity becomes increasingly important. The capacity to anticipate and take into account action goals of a partner is considered a fundamental cognitive capacity for successful cooperative behaviour in a shared task. We will report about our approach towards creating socially intelligent robots that is heavily inspired by recent experimental and theoretical findings about the neuro-cognitive mechanisms underlying joint action in humans. We believe that designing cognitive control architectures on this basis will lead to more natural HRI since the teammates will become more predictable for each other.

Central to our approach is a close action-perception link. The control model implements the joint coordination of actions and goals as a dynamic process that integrates contextual cues, shared task knowledge and the predicted outcome of the partner's motor behaviour. Ultimately, the model realizes a contextually appropriate mapping between observed and executed action. In known joint action tasks this process is rather automatic and does not require a fully developed human capacity for conscious control. It includes basic forms of automatic error detection and compensation.

We show results of the validation of the dynamic joint action model in a joint construction task in which the human-robot team assembles a toy vehicle from its components.

How difficult can it be? Fitts's law in action perception: an fMRI study

2

Terry Eskenazi[1], Pia Rothstein [2], Marc Grosjean [3] and Guenther Knoblich[1]

[1]Radboud University Nijmegen, NL; [3]Technical University Dortmund, DE

Fitts's law (Fitts, 1954) is one of most established laws of biological motion. It captures the speed-accuracy tradeoff observed in movement production as a function of 'index of difficulty' (ID) - a variable that relates the distance between two target points to the width of those targets. Accordingly, the time required to move between the target points would increase, as the distance increases, or as the target widths decrease.

Fitts's law has been shown to hold for many domains of movement production, with only a few exceptions. Importantly, it has been shown to hold for imagined as well as observed movements, in accord with the idea that these three action domains (i.e. imagery, action perception, action production) share a neural and a functional common ground. To further investigate this relationship we conducted an fMRI investigation of action perception, using a Fitts's-like setup. The results, in support of our hypothesis, indicate that the difficulty of observed action (reflected as the ID) drives the motor system.

Infants imitate joint action

1

Christine Fawcett and Ulf Liszkowski

Max Planck Institute for Psycholinguistics, NL

When infants observe two people acting together on an object, do they represent only the object-directed goals or do they also represent the social goal of acting together? In the latter case, when later imitating the observed action, infants should not only reproduce the object-directed action but also show attempts to engage the other in the action. In the current study, one group of 18-month-old infants observed two adults play together with six different toys across six trials. Following this demonstration, one adult left the room and the other adult gave the toy to the infant. A second group of infants saw only one adult play with each toy before receiving it. While infants played with the toy, their behavior was coded for attempts to engage the remaining adult by inviting her to play, asking her for help, returning the toy to her, or showing the toy to her. Infants who observed the joint action demonstration showed more inviting behaviors than children who saw the individual action ($t(30) = 1.79$, one-tailed $p = .04$), particularly on the first trial (Mann-Whitney $U = 96.0$, one-tailed $p = .02$). However, the other three types of engagement attempts did not differ across groups. Thus, infants in the joint condition were not simply more socially engaged with the adult. Rather, their more frequent attempts to invite her to play were a result of observing the joint action demonstration. Together, the results suggest that infants recognize and imitate others' joint action.

A preliminary investigation of the dynamics of interpersonal hand-clapping games

2

Paula A. Fitzpatrick[1] and Richard C. Schmidt[2]

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To investigate the development of social couplings in both normal and special populations of children, it is necessary to find a naturally-occurring interaction behavior to use as an experimental task. Hand-clapping games are an example of such an interpersonal coordination task. They typically involve two players engaging in a series of clapping patterns as they sing or chant a rhyme. Researchers have speculated that their use promotes cooperation and social bonding. Previous research has demonstrated that intrapersonal clapping behavior can be modeled as a complex synergistic system that is governed by a coupled oscillatory dynamic and used to evaluate the development of bimanual coordination. In the preliminary study, we investigate whether coordinated clapping movements performed between two people have similar dynamical underpinnings. We recorded the bimanual hand movements of two standing participants in a "Miss Mary Mack"-like hand-clapping game using a Polhemus Liberty system and manipulated both effector movement frequency and frequency detuning (by differentially weighting the arms). Dynamical analyses reveal that the strength of both intrapersonal and interpersonal limb couplings change as these control parameters are scaled allowing us to gain insight into the nesting of intrapersonal and interpersonal synergies that is fundamental to social motor coordination. We anticipate that understanding the dynamics of such clapping games will help to evaluate the development of social motor coordination and social bonding.

Learning joint control of a cursor in a shared task space

2

Caroline Gillett, Carl Jackson and Chris Miall

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We used two vBOT manipulanda in a novel reach-to-target task where two subjects jointly controlled the movement of a single on-screen cursor towards one of 4 targets. For each subject, randomly directed lateral force perturbations acted on the vBOT handle making movement toward two of the targets difficult; movement in the other two directions were unperturbed. The two subjects experienced one shared 'difficult' direction and one shared 'easy' direction; the other two directions were difficult for one subject and easy for the other. We hypothesis that subjects will learn, based on their own prior isolated experience of the task, which directions are easy or difficult for their joint actions. In addition, we predict that they will learn when it is advantageous (in terms of accuracy and speed) for them to contribute more heavily to the task, when movement to one target is easier for them than their partner. For efficient cooperative actions, the participant in the 'easy' condition should generate more of the shared cursor movement when their partner is in a 'difficult' condition. We probe learning using catch trials in which a visual perturbation is applied in the absence of force perturbations. We will discuss our results in the framework of optimal control.

Young children's understanding of joint activity in social play contexts

D

Maria Gräfenhain, Malinda Carpenter, Tanya Behne and Michael Tomasello

Max Planck Institute for Evolutionary Anthropology, DE

Human children seem to engage in joint activities with others in different contexts early in their ontogeny (e.g., Warneken, Chen, & Tomasello, 2006). However, little is known about what young children understand about joint activities, that is, whether they merely coordinate their actions with their partner in order to achieve an individual goal, or whether they truly understand joint activities as following shared goals creating joint commitments (Bratman, 1992; Gilbert, 1990).

To investigate this question, young children were engaged in games that they could play either alone, in parallel with another player, or jointly with another player. We assessed whether children adapted their behavior to the established play context. Results revealed that 1- to 4-year-old children are highly motivated to play jointly with an adult partner even when they could play the games alone. Two-year-old children seem to regard their partner as an intentional agent with whom they share goals and intentions. However, they also seem to regard another person as acting jointly as long as she acts in parallel with them. Only the 3- and 4-year-old children adapted their behavior to another person depending on whether or not they had previously formed a joint commitment to play together with that partner. Together the findings thus suggest that children develop a relatively sophisticated understanding of joint activity between 2 and 3 years of age. An ongoing study investigates how young children monitor and understand the role of their partner in a joint activity by assessing children's memory of joint activities.

Observing others reaching in our action space primes our own hand-path trajectories

2

Debra Griffiths and Steven P. Tipper
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Since the discovery of mirror neurons (Di Pellegrino, et al, 1992) there has been much research into the nature of what might be encoded when observing the actions of others. Converging evidence from both animal and behavioural studies indicates that the goal of an action is encoded along with the actions concerning that goal, such as grasping (e.g.Umilta et al. 2001), and indeed that observation of grasping can interfere with and prime one's own actions (e.g., Castiello et al., 2002; Castiello, 2003; Edwards et al, 2003). This study suggests that, in addition to encoding action goals, specific aspects of the path taken to reach the goal may also be encoded. When avoiding an obstacle, whilst reaching for a goal object, a person's hand path is necessarily higher to clear that obstacle. We demonstrate that the observation of such hand path deviation can prime one's own reach trajectory such that when reaching for an object without an obstacle that trajectory is higher. This priming can take place under a variety of circumstances, with or without a shared goal, and when the action is seen from a variety of perspectives. However for the action of the other to be simulated the obstacle avoided must be within the action space of the observer.

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Peers' mutual support when pursuing shared goals

1

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Several studies indicate that children's ability to cooperate with adults involves some understanding of joint goals (Warneken, Chen, & Tomasello, 2006; Warneken & Tomasello, 2007). One aspect of joint goals is that each partner should provide support for the other in the collaborative activity if needed. This insight can be used to test this understanding in peers.

Thus, we created two collaborative tasks to see if 2;6- and 3;6-year-old children are willing to provide support for the other. Both required joint engagement but used different dependent measures: collaboration or sharing. At one point in the joint activity one child depended on the other's unrewarded (altruistic) support. The main measure was whether the necessary assistance was provided. We also included a control condition that did not involve any previous joint engagement.

Preliminary data analysis yielded a significant age x condition interaction effect ($F = 7.36$, $p < .05$) for the collaboration task. That was due to the 3-year-olds helping significantly more often in the experimental condition, both compared to the control condition and to the 2-year-olds in general. Regarding the sharing task, the data available so far suggests a similar pattern with at least the older children distinguishing between conditions.

The current study tries to contribute new measures to examine shared goals and children's commitment to those goals in terms of mutual support, and finds that even peers seem to operate with joint goals.

The underlying mechanisms of task sharing

H

Antje Holländer and Wolfgang Prinz

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Common coding theory claims that perceived events and planned actions share a common representational domain. There is evidence that these representations may be shared between self and others. Investigating task sharing is one way of studying real-time social interactions. In this paradigm two individuals take care of a certain aspect of a common task. While a certain stimulus requires one of the agents to respond, in the same time this stimulus is action irrelevant to the other agent. Therefore, the task is performed in a turn-taking modus with only one agent responding at a time. There is evidence that although no interpersonal coordination is required, the task aspect of the other agent is taken into account as well. In the present study EEG was used to investigated the underlying neural mechanisms of co-representation in the task sharing paradigm.

The In-sync effect: Interpersonal synchrony increases affiliation

G

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The tendency to mimic and synchronize with others is well established. Although mimicry has been shown to lead to affiliation between co-actors, the effect of interpersonal synchrony on affiliation remains an open question. The authors investigated the relationship by having participants match finger movements with a visual moving metronome. In Experiment 1, affiliation ratings were examined based on the extent to which participants tapped in synchrony with the experimenter. In Experiment 2, synchrony was manipulated. Affiliation ratings were compared for an experimenter who either a) tapped to a metronome that was synchronous to the participant's metronome, b) tapped to a metronome that was asynchronous, or c) did not tap. As hypothesized, in both studies, the degree of synchrony predicted subsequent affiliation ratings. Experiment 3 found that the affiliative effects were unique to *interpersonal* synchrony.

Interpersonal coordination and interference: Synchronization and task sharing in a shared bimanual reaching paradigm

2

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Recent findings show that co-representation of another subject's task can affect processing of one's own motor task. The primary goal of this study was to investigate if not only a general action is co-represented but rather specific parameters of an upcoming action. A secondary goal was to figure out if unintentional synchronization processes between co-actors, so far found in rhythmic movements, will also show up in a discrete motor task.

Subjects shared a symbolically cued bimanual reaching task with varying movement amplitudes. A partial (individual) and a shared (joint) condition were conducted. Trials where both subjects performed their task simultaneously (go-go) and the ones where only one subject was required to respond in a time (go-nogo) were compared.

Interference in movement preparation processes was significantly stronger when a co-acting partner was required to perform a different action to one's own in comparison with a same action. In contrast to previous findings, it is remarkable that these effects did only appear in go-go trials but not in go-nogo ones.

Correlations between mean reaction times of dyads were calculated for both individual and joint condition. The individual condition didn't show any significant interrelations in the (pseudo-) correlations but a strong link between subject's movement initiation times was found in the joint condition.

Our results indicate that a task of a co-actor affects one's one performance to a greater extent when movements are performed concurrently. Synchronization processes might play a decisive role in Task Sharing and Joint Action.

The forward-looking nature of perception-action coupling as a basis for joint action

A

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Recent research on perception-action coupling indicates the following: (1) actions are planned in terms of the distal effects they are to produce and, (2) planning and perception share common neural resources. An immediate implication of such dual functionality is that perception entails forward-looking (i.e., intentional) content. The present talk will present research that indicates this anticipatory aspect of perception-action coupling contextualizes the perceptual space of an individual, such that the perceived vanishing point of moving stimuli is displaced further in direction of stimulus motion if one is allowed to control its movements, as opposed to simply observe them as they are controlled by a computer. Further research indicates this anticipation-laden, effect-relative (versus effector relative) context provides an agent-independent medium for planning that affords cooperative actions among multiple agents. Developing such intentional contexts however requires that both individuals and groups have access to the spatiotemporal relationships between actions and their effects. For individuals acting alone, knowledge about action-effect relationships can be internal because the effectors generating the effects belong to one agent. For groups acting cooperatively however, action options are distributed across different agents. Thus action-effect information must be externalized. The talk will conclude with a discussion regarding the extent to which this externalized aspect of cooperative group action constitutes a rudimentary yet fundamental basis for embodied communication.

Spatial perspective taking might have been shaped by the constraints of joint actions like learning by imitation

J

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Humans are able to mentally adopt the spatial perspective of others and "see the world through their eyes". We claim that spatial perspective taking (SPT) could have developed from the physical alignment of perspectives for joint action. That is, hominids might have realised at some point of evolution that physically adopting the same perspective as a conspecific was essential for a variety of collaborative tasks like learning by imitation. With increasing brain capacity the actual movement might have evolved into a mental re-alignment that provided more flexibility. This view conforms to the more radical stance in social psychology, which suggests that the demands of social interaction have in fact shaped perception, action, and cognition (e.g. Knoblich & Sebanz, 2006). In a series of 4 behavioural experiments we found substantial evidence that SPT is still rooted in embodied representations which are primarily action-related but involve large parts of the body schema. Our results reveal what the next step after automatic "mirroring" of conspecifics (e.g. di Pellegrino et al., 1992; Gallese, 2007, Kessler et al., 2006) might have been in the evolution of social understanding: the mental alignment of perspectives and the understanding of the visuo-spatial world from another viewpoint. Finally, our results indeed support the notion that SPT was constrained by physical alignment as required for specific joint actions (e.g. imitation). Such an embodied but conscious and deliberate transformation of the self into another viewpoint could have in turn subserved the planning and control of more sophisticated joint actions during evolution.

Do co-actors share tasks or actions? Evidence from a double response paradigm 2

Birgit Knudsen

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When humans perform a task together, they do not only form representations of their own task and actions, but also of the task and actions of their co-actor. Previous studies have repeatedly demonstrated detrimental effects of these so-called shared representations on response times in spatial compatibility tasks distributed among two participants. However, these studies have left open the question of whether these effects are caused by difficulties in keeping apart task representations or action representations. To investigate this, two experiments were conducted in which pairs of participants had to respond to stimuli that either required a response from both actors (double trials) or only a response from one actor (single trials). In Experiment 1, the two co-acting participants both had to respond with a similar action (button press). In Experiment 2, one participant of the pair had to press a button, while the other covertly counted his or her turns. The results of Experiment 1 revealed a response conflict on double trials compared to single trials for similar type of actions in the absence of conflicting tasks. In Experiment 2, however, no response conflict was observed when the action type was different for both participants. Taken together, these findings indicate that the detrimental effects of shared representations on response times in co-acting individuals are not caused by conflicting tasks, but by representing similar actions.

Acting together in and beyond the mirror neuron system

1

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Moving a set dinner table often takes two people, and doing so without spilling the glasses requires the close coordination of the two agents' actions. It has been argued that the mirror neuron system (MNS) may be the key neural locus of joint actions (JA). In Experiment I, we scanned 18 participants with fMRI while they we were engaged in JA in cooperation game with moving one of the two sticks of a clock-like device. In Experiment II, we scanned half of the participants while playing the same cooperation game (a) with the experimenter that adapts her movements to those of the participant or (b) with a computer that does not. Our results revealed that JA recruits two separable sets of areas: one that could translate between motor and visual codes and one that could integrate these information to achieve common goals. The former includes regions of the putative MNS, the latter, regions of the prefrontal, posterior parietal and temporal lobe adjacent to the pMNS. Moreover, the results of the Experiment II showed that both networks were more active while participants cooperated with a human agent, responding to their actions, compared to a computer that did not, evidencing their social dimension. These findings show that although the MNS can play a critical role in JA by translating both agents' actions into a common code, the flexible remapping of our own actions with those of others required during JA seems to be performed outside of the MNS.

Synchronization in joint action: From tapping to fire-walking

G

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Synchronization of actions, goals, and intentions among people is an important phenomenon in successful social interactions, which has been studied in both intentional and unintentional scenarios. It has been observed in coordination tasks requiring mutual information exchange between individuals, as well as scenarios of unidirectional coupling whereby one individual aligns with another through mimicking or simulation. In order to explore the dynamics and mechanisms involved in entrainment, a finger tapping experiment was carried out. Pairs of subjects were asked to tap on their respective keyboards following an 8-beat stimulus. They were instructed to keep the given beat as precisely as possible as well as synchronize with the 'other', while they received auditory feedback of themselves tapping, the other, or the computer metronome. Inter-tap interval analysis showed that dyads were unable to achieve full synchrony but rather in the attempt to lock in phase with each other, they corrected their tapping onsets in opposite directions. Windowed cross-correlations revealed high correlation in both lag +1 and -1 in the interactive condition, suggesting a shared continuous adaptation to the other's output. Unintentional synchronization was also considered in a second study, looking at heart rates of spectators and participants during a fire-walking ritual. Preliminary analysis revealed high synchronization among family members. Dynamical systems analysis showed that both types of interactions may be represented through varying degrees of coupling strengths between people, possibly correlated with their affinity to one another; however, even through indirect contact with each other, people do not adopt leader/follower positions.

Predictive action simulation depends on the task-induced social relation between actor and observer

1

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Radboud University Nijmegen, NL

Previous studies have shown that in joint action tasks, one simulates the action of one's partner, even prior to a prompted response. Interestingly, (pre)motor areas are activated during action observation and action anticipation in a qualitatively similar way as during motor execution. Our aim was to determine whether there are differences in (pre)motor cortex activation when people anticipate to observe an action performed by an interaction partner compared to an action performed by a person whom they never interact with. The experimental setup comprised three persons sitting around a table with a small object placed in the middle, on top of which visual stimuli were projected, consisting of a cue instructing the participant(s) to prepare an action and a subsequent go/no-go signal. Two of the participants ("partners") had either to swiftly lift the object and place it back or alternatively to pass it to their "partner". The other participant ("outsider") was only performing the lifting action individually. Pre-movement motor cortex activation, reflected primarily in the Contingent Negative Variation (CNV) and to a lesser extent in the beta Event Related Desynchronization (ERD) amplitudes, was significantly higher when participants anticipated to observe their "partner"'s action compared to the "outsider"'s action. This effect did not depend on the participants' spatial arrangement nor on the overall frequency of (individual and joint) action. Our findings suggest that predictive simulation of another person's action depends on the "social" relation between two persons, established through the frequent performance of spatiotemporally coordinated joint actions.

The role of language in conceptual coordination

B

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Although previous research has shown that people tend to align their descriptions of referents (Brennan & Clark 1996), little is known about underlying conceptual alignment, or language's role therein. Language no doubt helps people communicate their conceptualisations of things in the world, but is it crucial to conceptual coordination, or does it become redundant when people have an alternative and more direct heuristic, such as snapshots of concept extensions? We investigated this question using a free classification paradigm (Malt et al 1999), with participant pairs and a fluid space of morphed perceptual stimuli. Participants carried out a sequence of categorisation tasks, in each of which they freely sorted ten pictures of kitchenware like plates and bowls into self-labeled categories, trying to match their groupings with their partner's. There were three conditions. In the silent condition, participants saw their partners' categories at the end of each task, so they could learn how their partner was categorising. The talking condition was identical, except that participants were allowed to talk during the tasks. In the control condition, participants could not talk and received no feedback on their partner's categories. We found that participants coordinated very well in the talking condition, while the silent condition fared only slightly better than the control. However, subsequent individual similarity judgments and categorisation tasks revealed no differences between the conditions. These results suggest that linguistic communication is crucial to conceptual coordination, even when rich referential feedback is available, but that coordination does not persist beyond the interaction.

Joint acting and joint pointing at 12 months

1

Ulf Liszkowski

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Recent research has revealed the social complexities underlying infants' early pointing as joint communication. One question is whether parents' and infants' joint actions are related to their joint communicating. Here we report a correlational study.

In a new point elicitation task 20 of 39 twelve-month-olds and all but two parents spontaneously pointed. Points within 10 seconds of a preceding point of the partner were coded as 'responsive points' in a mutual activity. Parents' and infants' proportion of responsive points were significantly correlated, rho=.356, p=.042.

In a free play task, 20 of the same 39 mother-infant dyads have currently been coded. Half of these infants pointed in the elicitation task. We coded (i) interaction behaviors either as "following-into" or "directing" the other's activities (see Tomasello & Farrar, 1983); (ii) active and passive joint engagement (see Bakeman & Adamson, 1984).

Preliminary analyses: (i) Mothers show significantly more interaction behaviors than infants ($p < .001$), with no correlation between the two. There were no significant differences in the proportion of following-in vs. directing behaviors. Maternal and infant interaction behaviors did not differ between pointers and non pointers. (ii) Participants spent more time in passive than active joint engagement. Active joint engagement was significantly greater in the pointers than non-pointers ($p < .02$). Inside active joint engagement, the proportion of maternal directing behavior was significantly greater for pointers than non-pointers ($p < .003$). Ongoing analyses focus on the temporal timing of pointing and the number of objects played with.

Preliminary results support the view that joint acting and joint pointing are related. However, they also suggest that pointing is initially socially more coordinated than acting on objects. This sets the ground for a longitudinal study addressing the ontogenetic primacy of joint acting and communication.

Action representations in joint music performance 2

Janeen Loehr, Rowena Pillay and Caroline Palmer

McGill University, CA

Researchers have documented the activation of common representational structures by people taking turns or working together to achieve a common goal, but have yet to examine action representations in people producing independent actions that must occur simultaneously. The current research examined piano duet performance, in which two people produced separate musical sequences whose pitches were temporally coordinated, to determine whether representations of a co-performer's task are activated in temporally coordinated joint action. Pianists' timing accuracy was measured when they coordinated the performance of a right-hand melody with the performance of a left-hand melody produced by themselves (bimanual condition) or by another performer (joint condition). The left-hand accompaniment was manipulated so that it required repetitive movement of a single finger producing a percussion timbre (percussion condition), sequential finger movements producing a simple musical sequence (easy melody condition), or sequential finger movements producing a complex musical sequence (hard melody condition). Timing accuracy was reduced in the melody conditions relative to the percussion condition, indicating that coordinating with a sequence that required both pitch and movement transitions was more difficult than coordinating with a sequence that required neither pitch nor movement transitions. Reduced temporal accuracy in the melody conditions occurred across both bimanual and joint action conditions, indicating that these transitions had the same effect regardless of whether they were produced by the self or another performer. These findings suggest that pianists represent the pitches and movements produced by their co-performers in temporally coordinated music performance.

Auditory response effects do not activate between-person inhibition of return

2

Laura McDougall and Tim Welsh

University of Calgary, CA

It has been shown that inhibition of return (IOR), an effect thought to reflect inhibitory processes that facilitate an individual's visual search, is exhibited in multi-person response tasks. This between-person IOR effect is thought to occur because the observation of another's action evokes a representation of that response in the observer and that these response codes are subsequently accessed by other cognitive systems to activate the inhibitory processes underlying IOR. Evidence from other behavioural and neurophysiological studies suggests that presentation of an auditory response effect can activate the response codes that bring about the effect. The present study was conducted to determine if the presentation of the partner's response effect, in the absence of all other information, is sufficient to evoke a between-person IOR effect. Pairs of participants completed a series of goal-directed responses to targets that randomly appeared at one of two locations. High and low tones (response effects) were presented on individual button contact. In the key condition, one of the participants was prevented from seeing their partner's response and target information and was only given the auditory effect information to indicate the endpoint their partner's movement. We replicated previous findings of a within- and between-person IOR effect in full vision conditions. However, we did not observe an IOR effect in the key "effect-only" condition. These findings suggest that auditory effect information alone does not seem to evoke a strong enough representation of the other person's actions to activate the inhibitory processes underlying IOR.

The development of temporal coordination in joint and single actions during early childhood

1

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Temporal coordination of actions is crucial for acting alone as well as together with others. To date, however, the developmental relation between the ability to temporally coordinate one's own actions and the ability to temporally coordinate one's own actions with others has not been studied. The aim of the present study is therefore to investigate the development of temporal coordination in single and joint actions during early childhood. By means of a computer game, playable alone and jointly, we tested the performance of 30- and 42-month-old children. To achieve the game's goal, two buttons had to be pushed alternately. Each child played the game in two settings: a single condition (pressing both buttons) and a joint condition (pressing one button in turns with a joint action partner). The timing of button presses and the occurrence of errors by pushing one button at least twice were measured.

Preliminary results indicate that the 42-month-old children produced an alternating pattern of left-right button presses in the single and joint condition whereas the 30-month-old children produced an alternating pattern only in the single condition. It was found for the younger age group that the amount of errors in the joint condition was significantly higher than in the single condition. No such difference was detected for children in the older age group. These results suggest that temporal coordination during joint actions emerges later in development than temporal coordination in single actions.

Social group membership and interpersonal synchrony

G

Lynden K. Miles, Joanne Lumsden, Michael J. Richardson and C. Neil Macrae

University of Aberdeen, UK

The social implications of coordinated action have been documented following both the mimicry of discrete bodily movements and the coordination of more continuous sequences of action. The present study sought to extend on this work by examining the impact of social group membership on the spontaneous emergence of interpersonal synchrony. Participants were told they would be taking part in a group discussion regarding their aesthetic preferences, but that initially they would perform some light activity (arm flexion/extension) while forming an impression of another participant (actually a confederate to the study performing the same activity). Group membership was manipulated by assigning participants to arbitrary groups allegedly based on a (bogus) measure of aesthetic preferences. Importantly, the confederate was identified as belonging to either the same or a different group as the participant. The participant's arm movements were recorded using electrogoniometers and compared to those of the confederate. Differences in the relative phase relationship between the participant's and the confederate's arm movements were revealed as a function of group membership. Specifically, participants showed significantly more in-phase coordination when the confederate belonged to a different group than themselves. We suggest that, consistent with the effects reported with respect to mimicry being employed as an ingratiation mechanism, the synchronisation of action may act as a means to reduce perceived intergroup disparity in anticipation of future interaction. Furthermore, these findings reveal that the spontaneous emergence of interpersonal synchrony can be modified by minimal differences in group membership and social identity.

Social engagement leads 2-year-olds to over-attribute knowledge to others

D

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Previous research has shown that young children attribute knowledge to others most readily when they share experiences with them in joint attentional engagement (e.g., Nelson, Bakeman & Adamson, 2008; Moll, Carpenter, & Tomasello, 2007). In the current study, we tested the hypothesis that social engagement is so powerful that it can lead children to over-attribute knowledge to others. Two-year-old children (N = 120) played with an object an adult could not see, but in three of four conditions the adult engaged with the children in some way. Children were unable to identify the adult's ignorance, in each of these three conditions: when the adult was present (whether or not she communicated with children, both p's = .60) and when she was absent but communicated with them, p = .17. They only correctly attributed ignorance to the adult when she disengaged entirely, p < .01 (all p's 2-tailed). These results suggest that when young children are socially engaged with others—by being physically co-present or verbally engaged—they tend to assume a 'shared perceptual space' and over-attribute knowledge to others. Just as social engagement helps young children to understand what others are perceptually engaged with or know, it can compromise their ability to identify what others are not perceptually engaged with and do not know.

The rhythm of rapport: Interpersonal synchrony and social perception

2

Louise K. Nind, Lynden K. Miles and C. Neil Macrae

University of Aberdeen, UK

The temporal coordination of behavior during dyadic interactions is a foundation for effective social exchange with synchronized actions enhancing perceptions of rapport and interpersonal connectedness. What has yet to be established, however, are the precise characteristics of behavioral coordination that give rise to such effects. Informed by a dynamical systems approach, the current investigation considered whether judgments of rapport are influenced by the mode of interpersonal synchrony. In two experiments, participants rated the degree of rapport manifest by a simulated pair of walkers exhibiting various configurations of synchronized strides. The results revealed that the highest levels of rapport were associated with the most stable forms of interpersonal coordination (i.e., in-phase and anti-phase synchrony), regardless of whether coordination between the walkers was conveyed via the presentation of visual (Expt. 1a) or auditory (Expt. 1b) cues. These findings underscore the importance of interpersonal coordination to core aspects of social perception.

Agency, intentional binding and co-intention

2

Sukhvinder S. Obhi, Kristin House and Lars Strother

Wilfrid Laurier University, CA

Voluntary actions and external effects are perceptually bound in time when the action causes the external event. For example, Haggard et al (2002) have shown that judgments of a key-press and a resultant auditory tone are bound together in perceived time when the key-press causes the tone, compared to when the key press and tone occur in isolation, or the action causing the tone is involuntary. This effect is referred to as 'intentional binding' (IB) and has not been reliably demonstrated when individuals judge the times of another's actions and their corresponding effects. In the current study, using a similar set up to Haggard et al (2002) we asked two participants to simultaneously prepare to press the same button, but to let the other person press it if they moved first. From each participant on each trial, we obtained subjective judgments of agency in the form of a yes/no answer to the question "did you press the key?", as well as the perceived time of occurrence for key-presses (KPs) and tones (Ts). We observed similar IB for KPs and Ts for both participants regardless of whether or not the individual actually performed the causal action, and importantly, irrespective of whether they had any subjective experience of agency. Our results suggest that intentional binding occurs equally for actors and non-actors, as long as individuals are co-intending to act prior to the action. Finally, these results reveal that the subjective experience of agency is not the product of IB.

Beyond small-scale, egalitarian actions: coordination tools and normative thinking

B

Elisabeth Pacherie

Ecole Normale Supérieure, F

In small-scale, egalitarian joint actions involving face to face interactions, the coordination of individual actions in the pursuit of a joint goal is made possible in a large part by various forms of exploitation of perceptual information. Thus, joint attention and motor resonance mechanisms allow individuals to share representations and to predict the actions of their co-agents. If these were the only kinds of mechanisms at our disposal to promote coordination, there would be sharp limitations to the kind of joint actions we can successfully engage in. Yet, human agents have been able to overcome these limitations. They engage in complex joint actions that involve large numbers of co-actors, where these co-actors don't always have common perceptual grounds, where interactions can be virtual rather than physical, and where actors play specialized roles. In this talk, I explore the different kinds of 'coordination tools' (pre-established scripts, hierarchical organization, division of labor, coordination artifacts) that allow coordination towards a joint goal to be achieved in complex forms of joint action and examine the form their respective contributions to joint action take. I also consider the kind of cognitive abilities complex joint actions tap. In particular, I argue that these coordination tools involve central elements of normativity and discuss the capacities for deontic thinking needed to create and exploit them.

Interpersonal coordination among performing musicians

Caroline Palmer and Werner Goebl

McGill University, CA

Musical ensemble performers must coordinate their actions in relation to the timing of other parts, while fulfilling intentional roles as leader (primary part) and follower (accompanist). We tested influences of auditory feedback and musical roles in how members of piano duets synchronized their performances. Pianists performed two-part music during motion capture; one pianist was designated the leader (higher-pitched melody) and the other pianist was the follower (lower-pitched accompaniment). Each member of the piano duet took turns being leader and follower. They received full auditory feedback, one-way feedback (leaders heard themselves while followers heard both parts), or self-feedback. Temporal asynchronies between pianists increased when pianists performed more notes under reduced auditory feedback. Variability measures of timing (coefficients of variation) indicated that the follower was more variable than the leader, consistent with error correction in response to tempo changes. In addition, pianists' interonset timing suggested bidirectional influences during full feedback despite the leader/follower instructions, and unidirectional influence (from leader to follower) during reduced feedback. Leaders' finger and head movements became larger and follower's head movements became more synchronized with those of leaders as auditory feedback was reduced. These findings suggest that interpersonal coordination among musicians is bidirectional under natural feedback conditions even when intentional musical roles are directional, and that visual-motion cues become more important in the absence of sufficient auditory information.

The influence of the observer's posture on body-form compatibility effects

2

Stephanie Paulson, Laura McDougall and Tim Welsh

University of Calgary, CA

Behavioural, neuropsychological, and neuroimaging studies suggest that humans possess a "human" body representation. This body representation is thought to have a role in self-other matching, imitation, and empathy. In a recent study, we have found that this human body representation is engaged when people view humans in a bipedal (standing) posture, but may not be engaged when people observe humans in a quadrupedal (on all-fours) stance. Because participants in the previous study were sitting upright while looking at the human forms, it might be that the upright posture of the participant mediated the activation of the human body representation such that the quadrupedal stimuli (which were in a different posture from the participant) did not have access to the human body representation. The present study examined if the posture assumed by the individual influences access to the body representation by exploring reaction time compatibility effects when an observer views a human body in a bipedal or quadrupedal posture when the observer is in an upright or quadrupedal posture. Participants completed a series of compatibility tasks in which they responded with a hand or foot movement when the appropriate colour stimulus (red and blue, respectively) was presented over the hand or the foot of a human picture. The results show that the posture assumed by the participant modulated the effector-based compatibility effects. These findings suggest that the action- and/or posture-state of the observer influences the manner in which observed body forms access the human body representation.

An agent-based joint compatibility effect

Andrea M. Philipp[1, 2] and Wolfgang Prinz [1]

[1]Max Planck Institute for Human Cognitive and Brain Sciences, DE; [2]RWTH Aachen University, DE

To explore the impact of social context on individual performance, we developed an interference task with socially relevant but task-irrelevant stimuli (own face, neutral face, a friend's face). Participants were required to perform naming responses to colored diamonds (relevant dimension) superimposed on faces (irrelevant dimension). We observed faster responses in compatible as compared to incompatible conditions (agent-based compatibility effect). When the task was distributed among two friends we observed an agent-based compatibility effect in a joint go/no-go condition, in which both participants performed their go/no-go tasks together (agent-based joint compatibility effect). In contrast, no compatibility effect was obtained in an individual go/no-go task. Further results from our experiments indicated that the joint compatibility effect was based on the compatibility between face and the identity of the responding agent. We take our findings to show that features of the responding agent may play a crucial role in joint compatibility effects.

Interpersonal coordinative structures in a joint-precision task

F

Verónica C. Ramenzoni, Michael A. Riley and Kevin Shockley

University of Cincinnati

Important contributions to our understanding of coordination both within and across agents have come from the application of self-organized dynamical systems theory. According to this approach, coordination relations reflect the activity of coordinative structures (i.e., temporary assemblies of neuromuscular elements that reduce the degrees of freedom to be controlled in a particular movement sequence). We investigated whether interpersonal coordination during the performance of a supra-postural precision task gives rise to an emergent, joint coordinative structure defined across individuals. A second goal of this project was to investigate whether a joint coordinative structure would change in response to increments in precision task demands. Coordination of hand, arm, forearm and torso movements was measured when two participants performed a supra-postural precision task jointly or when two participants simultaneously performed either part of the task independently of one another. Principal Component Analysis (PCA) was performed on each participant's data (i.e., intrapersonal analysis) and on the combined data from both participants (i.e., interpersonal analysis). The interpersonal analysis showed that the principal components defined within each person were significantly more coordinated, as evidenced by cross recurrence analysis performed on time series of the data projected onto the principal component axes, under greater precision requirements. Interpersonal PCA showed that the experimental task required significantly fewer components to account for 90% of the variance than the control task. These findings suggest that PCA and CRQA can be used to identify coordinative processes which can motivate future specific hypotheses about the nature of joint coordinative structures.

The immediate and short term effects of action observation on the motor system

C

Matthew Ray[1] and Tim Welsh[1]

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The mirror neuron system (MNS) is a network of neurons which become active during the execution and observation of actions. It has been proposed that the MNS is the neural basis for many social cognitive processes, such as imitation and observational learning. The MNS may play a role in observational learning because the response representation activated in the MNS during action observation may subsequently activate related response codes in the motor system. Through repeated observations and MNS-mediated motor system activations, existing response codes may be honed or new ones may be developed. If the MNS is involved in observational learning, then there should be a relationship between the immediate and short term effects of action observation on the motor system. This hypothesis was tested by using TMS to examine the relationship between the immediate and short-term effects of action observation on the motor system. The immediate effect of action observation was determined by measuring the increase in motor evoked potentials (MEPs) during action observation. The short-term effect of action observation (observational learning) was measured as the change in TMS-evoked movements following repeated action observation. It was found that the immediate and short-term effects of action observation were highly correlated which indicates that participants who had the largest increase in MEP amplitude during action observation also had the greatest learning effect. The finding of the present study provides evidence that the MNS is the neural basis for observational learning.

Joint perception

E

Daniel C. Richardson, Merrit Hoover and Arezou Ghane

University College London

In two experiments we explored a new phenomenon of 'joint perception': participants' eye movements were influenced by the belief that they are either looking at pictures alone, or that a person next door is looking at the same pictures. In each experiment, participants saw sets of four pictures for a period of eight seconds. One picture a positive and one a negative valence, and others were neutral. On a trial by trial basis, participants' are told that either they are looking at the same pictures as another participant sat next door, or that only they are looking at the pictures, and the other participant is looking at random symbols. We found an interaction between overall looking times to the positive versus the negative pictures, and participants belief that they were looking alone or jointly. When looking jointly, participants spent more time looking at the positive pictures, but this preference reversed when they believed they were looking alone.

A second experiment manipulated the beliefs participants had about the person in the next cubicle. Surprisingly, the knowledge that the other participant liked positive images resulted in a preference for negative images in the joint condition as well.

In each case, a minimal sense of cooperation with another appears to produce distinct cognitive effects, in manner similar to that found in studies of 'joint action'. We conclude that there may be a pervasive effect of social context upon cognitive and perceptual processes.

Dynamics of interpersonal movement interference: Effects of intention, attention, and agency

F

Michael J. Richardson

Colby College, USA

Previous research has demonstrated that motor interference occurs when an actor coordinates with spatially incompatible movements of another individual. Specifically, the rhythmic arm movements of the actor exhibit increased movement variability in the plane orthogonal to the instructed plane of motion. A series of experiments investigated whether such motor contagion reflects the spontaneous recruitment of additional task-specific movement degrees of freedom employed to withstand increasing task difficulty. The experiments also examined the effects of a participant's intended coordination goal, attention to relevant movement information, and expected agency of the perceived movement on the dynamics of interpersonal movement interference. Participants coordinated congruent and incongruent forearm movements under various coordination goals (intentional, unintentional) and attentional requirements, as well as differing agency manipulations (the participants performed the task with a confederate, a computer stimulus, or a computer stimulus which represented 'real' human movements). As expected, a dynamical analysis of the participants' instructed and non-instructed plane movements revealed that interpersonal motor interference can be understood as an emergent property of a coordination goal and that the magnitude of the effect is dynamically modulated by intention, attention, and agency. More importantly, is the ensuing prospect that the methodologies and analyses employed in these experiments permit the dynamical systems and neuro-cognitive approaches (e.g., common-coding, motor resonance) to interpersonal perceptionaction phenomena to be integrated in order to provide a more cohesive multilevel model of jointaction behavior.

Gesture learning through imitation during social interactions

1

Amir Sadeghipour and Stefan Kopp

Bielefeld University, DE

During conversation and, generally, social interactions, humans try to get coordinated to reach a set of shared beliefs (grounding). The addressees in a conversation use both language and gesture, as forms of joint actions, to clarify their meanings and to make a common ground. In this regard, gestures, as means of signaling meaning, need to be both produced and recognized. Imitation is one social learning mechanism, which makes it possible for humans, on the one hand, to learn how to perform novel gestures, and on the other hand, to recognize familiar gestures and consequently associate them with meanings they refer to in context. We propose a computational model, which enables a humanoid virtual agent to recognize and produce gestures through imitation. Our model comprises two different routes for imitating novel and familiar gestures. First, an inverse model segments novel gestures into primitive motor acts, and stores them in a virtual motor cortex in the form of a graph. Second, during observing a familiar gesture, a forward model employs this graph to predict the intended gesture using probabilistic models. Scaling this principle up to multiple hierarchical levels, we define motor schema as a prototype of various performances of a gesture. Hence, the meaning of gestures can be associated with motor schemas, independent of the irrelevant features of their different performances. In this way, we model both performing and recognizing gestural actions in a unified way – a prerequisite for considering gestural communication as a form of joint activity toward achieving common ground.

The influence of social intentions on the on-line control of action

E

Luisa Sartori[1], Cristina Becchio[2], Maria Bulgheroni[1] and Umberto Castiello[1]

[1]University of Padova, I; [2]University of Torino, I

The influence of a sudden social request on the kinematics of a pre-planned action was investigated.

In Experiment 1 participants were requested to grasp an object and then locate it within a container (unperturbed trials). In 20% of trials a human agent seated nearby the participant unexpectedly stretched out her arm and unfolded the hand as to ask for the object (perturbed trials). In Experiment 2 we replaced the human agent with a robotic agent, while in Experiment 3 and 4 the gesture performed by the human agent did not imply a social request or her gaze was not available.

The results for Experiment 1 revealed that in the presence of the perturbation participants were potently driven towards the experimenter in order to accomplish the social request despite the task instructions. The human default mode prompts us to interact with others in a complementary fashion. During perturbed trials participants approached the object with slower reaches and longer time to maximum grasp aperture compared to those in the control condition. When the eyes of the human agent were covered, perturbation effects were delayed, suggesting that the perceived intentionality of the movement was crucial as to determine the reported effects. The results indicated also that motor response varied depending on the nature of the perturbation. Only a human gesture conveying a social request modified pre-planned actions.

These data suggest for the first time that the exposure to a sudden social request produces reliable changes on the action on-line control system through on-line integration of the other's actions.

Dynamics of activity in structured conversation

A

Richard C. Schmidt

College of the Holy Cross, USA

Past social psychological research has revealed that in natural social interactions body activity increases and decreases in a rhythmic fashion and thus creates behavioral 'waves' of activity. Further this research has found that the behavioral waves of an individual (e.g., speech and hand movements) were entrained with each other (self-synchrony) as well as with the behavioral waves of other people with whom they were interacting (interactional synchrony). The goal of the present study is to investigate whether the interpersonal coordination of the generalized body activity seen in natural interactions has the criterial properties of dynamical synchronization—a process which has been found to organize rhythms at many scales of nature. To evaluate this, a structured interaction task was used. Two participants stood facing one another and told each other a series of jokes which require the response of the other person (i.e., 'knock-knock' jokes). These interactions were videoed and the movements of participants' heads and dominant arms were recorded using a Polhemus Liberty system. Both rater-coded and integrated Polhemus time series of activity revealed behavioral waves which had spectral harmonics indicative of periodicities. Analysis of the coupling of these activity waves using cross-spectral and relative phase methods revealed that the moment-to- moment actions of the two individuals were correlated and phase entrained. These results are commensurate with past research that has found unintentional interpersonal synchrony in more stereotyped rhythmic tasks and suggests that the coordination of activity in natural interactions is constrained by processes of dynamical synchronization.

I will remember you: Enhanced memory for information pertaining to a relevant other

1

Natalie Sebanz[1], Terry Eskenazi[1], Adam Doerrfeld[2] and Guenther Knoblich[1]

[1]Radboud University Nijmegen, NL; [2]Rutgers University Newark, USA

Our actions are not carried out in isolation; we constantly and sometimes unintentionally coordinate our actions with others. When sharing a task, we plan our actions in a complementary manner to our co-actors', and in doing so we form representations of their action plans. Co-representation refers to this sharing of mental representations in social interactions.

I will present data from two new experiments that aimed at investigating whether forming shared action and task representations affects how information relevant to self or other is encoded in memory. Participants performed a categorization task alone and together. Their memory for items they had earlier responded to, items the other had responded to, and items no one had responded to was subsequently tested. We found that participants were able to not only recall items that had been relevant for their own task, but also items relevant to the other's task. In contrast, they were much worse at recalling information that was neither relevant to self nor other. This was the case even though there was no explicit requirement to coordinate, and the memory advantage for items relevant to the other's task remained even when participants were given financial incentives to fully focus on their own task. These findings suggest that we may be so prone to taking others' tasks into account and that we just don't manage to ignore each other.

The feel of joint action

J

Rene Selich (formerly Sebanz and Knoblich)

Radboud University Nijmegen, NL

Informal observations suggest that joint action deeply affects individuals' experience of control. This ranges from total loss of control in group-rituals to heightened self-awareness in joint performance. Joint action also involves feeling control over others and feeling controlled by others. Acting together may even lead us to experience group control in addition to individual control. This talk will tell some short stories about the feel of joint action and discuss whether there is any chance to address this feel in controlled experiments.

Can joint action facilitate visuo-motor coordination? J

Michael Spranger

Sony Computer Science Laboratory Paris, F

The formation and maintenance of a body image is a necessary requirement for autonomous agents. It is needed to control bodily movement, plan actions, recognize and name actions performed by others, and request or execute commands. Through experiments with autonomous humanoid robots, we show what role joint action, especially joint action games, can have in the formation of such a body image. The problem of body image formation is considered here as a co-ordination problem, that is solved by agents through joint interactions. Robots play a situated embodied language game called the Action Game in which they ask each other to perform bodily actions. Through setting up the right kind of mechanisms and semiotic dynamics we demonstrate the self-organisation of a successful communication system about bodily movements without agents a priori knowing the relation between visual images of motor behaviors carried out by others and their own motor behaviors. By employing the right cognitive strategies, agents progressively construct an eective lexicon as well as bi-directional mappings between the visual and the motor domain. Two experiments are put forward to illustrate the approach. In a rst experiment robots learn the bi-directional mapping between visual body-image and motor behavior by standing before a mirror, executing actions, and observing the visual body-images that they generate, before engaging in action games. In a second experiment robots do not learn the bi-directional mapping between image schemata and motor body-image through a mirror but through the language game itself. Therefore the experiments, most importantly the second one, hint at the role joint social interactions might play in linking actuation and perception even on a very basic level.

Adaptive embodied communication: Teaching sequences of actions by real and virtual humans

1

Yvonne Steggemann, Stefan Kopp and Matthias Weigelt

Bielefeld University, DE

Instructions about sequences of actions are better memorized when they are offered with appropriate gestures. In this project, the virtual human MAX (Multimodal Assembly Exert) serves as a teacher to human listeners, who are novices at particular tasks. Equipped with a synthetic voice and an articulated body and face, Max is able to speak, to mimic emotions, and to accompany his verbal instructions with self-generated gestures. Multimodal instructions about action sequences (e. g. tying a tie) lead to memory representations in the human observer/listener. The quality of these representations is assessed by MAX himself using the 'structure dimensional analysis – motoric' (SDA-M). This provides for a measure of observers/listener's comprehension and can, in turn, be used by MAX as a basis for the adjustment of his future use of particular instructions and gestures in this interaction scenario. Hence, the present project builds up a closed-loop interaction scenario between the virtual agent MAX and non-virtual humans, in which both agents learn from each other through the exchange of information. The basic tenets of the project are introduced and its particular features, as well as the possibilities for application are discussed. Thereby, the focus will be on the alignment of speech, mimicry, and gestures that accompany the multimodal utterances of MAX.

Collaborative problem solving and spontaneous role reversal in 2- and 3-year-old peers

1

Jasmin Steinwender, Felix Warneken and Michael Tomasello

Max Planck Institute for Evolutionary Anthropology, DE

The ability to collaborate skillfully with peers emerges at around 24 months of age. Although children of this age can successfully solve simple problem solving tasks which require the engagement of two partners, their behavioral coordination remains rudimentary (Brownell & Carriger, 1990; Brownell, Ramani & Zerwas, 2006).

In the current study we systematically investigate problem solving with complementary roles in peer dyads of two age groups: 24 and 36 month of age. We use two cooperative problem solving apparatuses. Rather than assigning children to which of two complementary roles they are supposed to play, peers had to coordinate with the partner who would perform which role and can reverse roles spontaneously. To assess how much instruction is needed at a given age, we gradually increased the instructional guidance until children succeed in the problem solving tasks. All sessions were coded for (1) the children's capability to coordinate their actions with that of the partner, (2) the frequency of spontaneous role reversal, and (3) latency to success.

Preliminary data (N = 12 dyads) show that 24-month-olds as well as 36-month-olds are able to cooperate with a peer partner at the lowest instructional level. Spontaneous role reversal occurred frequently in both age groups: All dyads produced role reversals at least once, on average in 40% of trials. The current study will enable us to further elucidate the emerging cognitive abilities needed for cooperative problem solving as they develop between 24 and 36 months of age.

Assessing visual information in a collaborative table tennis task

2

Stephan Streuber

Max Planck Institute for Biological Cybernetics, DE

Classically the process of human interaction was assumed to rely mainly on higher-level cognitive processes (e.g. inference) whereas more recent evidence suggests that lower-level (e.g. perceptual) processes may play an important role. These findings suggest that information about the interaction partner is beneficial for the performance of a joint task. In order to test this hypothesis we designed a cooperative table tennis task in which we manipulated visual information about both interaction partners (e.g. about the paddles and about the body movements). We found that joint task performance increases, if this additional information is available. Therefore, we concluded that information about the other's actions and/or information about the own actions seem to be an important source of information for the performance of a joint task. In a second experiment we addressed the question of whether joint performance profits from participants perceiving their own actions (e.g. seeing their own paddle) or from participants perceiving the interaction partner's actions (e.g. seeing the other's paddle). The result will shed light into the processes which govern human interaction.

Neural mechanisms of social coordination: Continuous EEG analysis using a novel 4d colorimetric method

A

Emmanuelle Tognoli, Daniela Benites, Gonzalo C. De Guzman and J. A. Scott Kelso

Florida Atlantic University, USA

Dynamical systems are often characterized by states (during which a behavior is sustained) and state transitions leading from one behavioral regime to another. The latter are information-rich but until now, tools to analyze their associated neural dynamics were lacking. To understand the brain mechanisms of behavioral coordination between people, we focused on the transition from uncoordinated to coordinated social behavior. We developed a 4D colorimetric method to analyze EEG spatio-temporal patterns associated with these behavioral transitions. We applied this technique to the continuous EEG of two people engaged in intentional social coordination. Subjects performed rhythmic right index finger movements in full view of each other under instructions to establish one of three collective behaviors: inphase (both fingers flex/extend in synchrony), antiphase (one subject extends while the other flexes) and intrinsic (both subject maintain their own movement and do not intend to synchronize). Transitions to coordinated behavior were identified and classified according to agency, i.e., who effects the transition, task goal, and behavioral strategy. For both partners, we identified brain patterns that were: (1) specific to a class of coordinated behavior, and (2) observed irrespective of the mode of coordination. The potential of this new method to understand the brain mechanisms of joint action will be discussed.

I don't mind how you do it: Acting together with real persons versus animated hands

H

Jessica Chia-Chin Tsai, Günther Knoblich and Natalie Sebanz

Radboud University Nijmegen, NL

Co-representation effects that occur when people perform tasks together may depend on attributing intentions to the co-actor or may depend on how well observed actions can be integrated in one's own action planning. To investigate the relative contribution of these two factors a modified joint Simon task was used. The stimuli — red or green lights appearing at one of three locations at a time — were presented at the centre of a tilted computer screen. Participants always put their right hands on the right side of the screen and responded to one color only. On the left side, a right or left hand either of a real person or a video recording of human hand actions was shown. Thus, a hand always "responded" to the alternative color targets with another key. While the Simon effect was of equal size regardless of whether the real co-actor used their right or left hand to respond, interacting with an animated left hand rather than with a right hand triggered a larger compatibility effect. Further experiments revealed the same pattern of results for actions involving tool use, such as knife and fork used congruently (knife right) or incongruently (knife left). Animated left hand actions were integrated to a larger extent because this configuration fits with one's own body schema and resembles performing the Simon task bimanually. In contrast, these effector differences for animated actions can be eliminated in real-person interactions, suggesting that the specific way in which the other implements their actions is ignored.

Corepresentation of others' action alternatives: Does Hick-Hyman law hold for self and other?

2

Robrecht P.R.D. van der Wel, Günther Knoblich and Natalie Sebanz

Radboud University Nijmegen, NL

It has been proposed that people corepresent each other's tasks when they act together (e.g. Sebanz, Knoblich, Prinz, 2005). In a series of experiments, we tested this claim by manipulating the number of action alternatives for two actors. According to Hick-Hyman law, reaction time increases with the number of response alternatives for an individual. If people corepresent others' tasks, performance should not only depend on the number of personally relevant action alternatives, but also on the number of action alternatives a coactor has. Analyses of reaction times and errors provide first evidence that performance is indeed modulated by the number of action alternatives available to one's co-actor. The results indicate that taking into account social factors can shed new light on cognitive models of human performance.

Levels of action representation in the human mirror neuron system

C

Hein van Schie

Radboud University Nijmegen, NL

Theoretical claims about the functional role of the mirror neuron system (MNS) range from low level motor resonance to high level action understanding. However, many of the available studies thus far can be explained by low level properties of mirror neurons, i.e. motor resonance. In this talk I will present several recent findings from behavioral, magneto-encephalographic and neuroimaging studies that suggest higher levels of action representation, supporting action understanding and complementary actions, may indeed find a functional basis in the human MNS. Results argue for a general role of the MNS in action perception coupling and suggest a functional parcellation of the MNS in different levels of action representation, e.g. distinguishing between action goals and action semantics.

Coordination strategies in joint action tasks with timing constraints

Cordula Vesper

Radboud University Nijmegen, NL

Many joint action tasks require precise, well-coordinated timing of individual actions in order to ensure smooth joint performance. Two studies will be presented that, despite profound differences in experimental design and task instructions, both suggest that people use general strategies to overcome timing constraints during joint action tasks. In Study 1, a computerized forced-choice response task (Simon task) was used to examine performance differences of pairs of participants who were instructed to coordinate their responses such that they occurred either in close succession or simultaneously. Study 2 used a more natural setting in which pairs of participants had to build an object from wooden bricks, in order to investigate how movement parameters are adapted to the partner's actions. Both studies suggest that, compared to an individual baseline, participants specifically modified their task performance. In particular, participants in both studies sped up the execution of their button presses / hand movements. This helped e.g. to reduce response variance or to reduce the danger of limb collisions in the shared workspace. The results are consistent with the idea that faster task performance in combination with other behavioral modulations provides a general strategy that is specifically applied to joint action contexts and that serves to facilitate coordination with an interaction partner.

Neurophysiological modulation of human motor cortex during the observation of grasping movements: A transcranial magnetic stimulation study

2

Michael Villiger[1,2], Sanjay Chandrasekharan[2] and Tim Welsh[2]

[1]ETH-Zurich, CH; [2]University of Calgary, CA

Studies of both monkeys and human have shown that there is a neural system that becomes active when an action is observed and when the same action is executed - the mirror neuron system (MNS). Previous studies of the monkey MNS have revealed that the activation of this system during the observation of grasping movements is modulated by the presence of a to-be-grasped object (Umilta et al., 2001). Critically, the object and the action on the object does not need to be seen for this modulation to occur suggesting that the modulation is dependent on the observer knowing that an object is present and acted upon. The purpose of the present study was to determine if the human MNS and motor system is modulated in a similar manner. TMS was used to elicit motor evoked potentials (MEPs) of grasping muscles while participants observed actual or pantomimed grasping movements on an apple. In some conditions, participants saw the whole movement while in other conditions the participant was prevented from seeing the grasping portion of the movement by a screen. The findings were generally consistent with the Umilta et al. (2001) study in that MEP amplitude was modulated by object presence and that the modulation was observed in full and partial vision conditions. Interestingly, an inhibitory, as opposed to an excitatory, influence was observed. These results will be discussed with respect to implications for the understanding of the human MNS and the interaction between the MNS and the motor system.