



9th Joint Action Meeting

July 10-12, 2023

Budapest, Hungary

Organized by:

Andrea Jenei¹, Günther Knoblich¹, Ivana Konvalinka²,
Natalie Sebanz¹ and Anna Zamm³

¹Central European University

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Program

Monday, July 10 th	
8:00 - 9:00	Registration
9:00 - 9:20	Welcome
9:20 - 11:00	Talk session A: Synchrony
11:00 - 11:20	Coffee break
11:20 - 13:00	Talk session B: Joint Goals
13:00 - 15:30	Poster session 1* + lunch break
15:30 - 17:10	Talk session C: Music
17:10 - 17:20	Break
17:20 - 18:20	Talk session D: Attention and Co-representation
18:30	Drinks at rooftop and posters on display

**Presenters are encouraged to be at posters from around 13:30.*

Tuesday, July 11 th	
9:00 - 11:00	Talk session E: Communication
11:00 - 11:20	Coffee break
11:20 - 12:40	Talk session F: Agency and Commitment
12:40 - 14:00	Break
14:00 - 16:00	Talk session G: Hyperscanning
16:00 - 16:20	Coffee break
16:20 - 18:00	Talk session H: Cooperation/Decision Making
18:30	JAM dinner + party on rooftop

Wednesday, July 12 th	
9:00 - 11:00	Talk session I: Human-Robot/AI-Interaction
11:00 - 11:20	Coffee break
11:20 - 13:00	Talk session J: Language
13:00 - 15:30	Poster session 2* + lunch break
15:30 - 16:50	Talk session K: Neural Mechanisms
16:50 - 17:00	Break
17:00 - 18:00	Talk session L: Improvisation and Connection
18:00 - 18:30	Final remarks

**Presenters are encouraged to be at posters from around 13:30.*

Talk sessions

Talk session A: Synchrony

Mon, 9:20 - 11:00

Anna Zamm, Simon Lind Kappel, Ivana Konvalinka, Stefan Debener, Preben Kidmose

Social coordination in and out of synchrony: How do groups implement joint musical actions?

Sarah Boukarras, Valerio Placidi, Federico Rossano, Vanessa Era, Matteo Candidi

The emergence of physiological synchrony during joint action and its association with task-related motor parameters and dyadic personality traits

Ivana Konvalinka

The social, decoupled self

Ryssa Moffat and Emily S. Cross

Observer's traits predict accuracy of synchrony estimation and enjoyment of dyadic mirror-game movements

Jamie A Ward and Antonia Hamilton

How to quantify interpersonal synchrony in autism using wearable sensors

Maximilian Marschner and Günther Knoblich

Associative Learning of Joint Action Representations

Matilde Rocca and Marcel Brass

Motor contagion of multiple agents: a kinematic analysis

Margherita Adelaide Musco, Eraldo Paulesu and Lucia Maria Sacheli

Utilitarian helping hands: self-serving support in small-scale interactions

Silvia Formica and Marcel Brass

Neural evidence for anticipatory representations during Joint Actions

Bianca Bonato, Valentina Simonetti, Qiuran Wang, Silvia Guerra, Maria Bulgheroni and Umberto Castiello

"United we stand, divided we fall": intertwining as evidence of joint actions in plants

Thomas Wolf, Natalie Sebanz and Günther Knoblich

How do work songs stabilize the tempo of rhythmic joint actions?

Francesca Ciardo, Marta Radice, Rokas Maksevičius and Peter E. Keller

Impact of errors on temporal adaptation and anticipation mechanisms during musical joint action

Valentin Bégel, Alexander P. Demos and Caroline Palmer

Short-term duet interventions affect subsequent synchronization and social interaction

Jan Stupacher

Empathy increases social bonding in interpersonal interactions that feature music and influences the pleasurable urge to move to music

Laura Bishop

Mental effort and expressive interaction in expert and student string quartet performance

Talk session D: Attention and Co-
representation

Mon, 17:20 - 18:20

Dominik Dötsch and Anna Schubö

*Behavioral and EEG Evidence For Attentional Capture By A
Partner's Target*

Orit Nafcha, Simone Shamay-Tsoory and Shai Gabay

*The Three Pillars of the Social Inhibition of Return Effect:
The Task, the Partner, and the Context*

Chifumi Sakata, Yoshiyuki Ueda and Yusuke Moriguchi

*Spontaneous Emergence of the Joint Memory Effect in Visual
Search*

James Trujillo and Judith Holler

Investigating the Multimodal Compositionality and Comprehension of Intended Meanings Using Virtual Agents

James W.A. Strachan and Cristina Becchio

Building demonstrations from scratch: Understanding pedagogical communication in teaching interactions

Mateusz Woźniak and Guenther Knoblich

Communication and action predictability: two complementary strategies for successful cooperation

Martin Dockendorff, Judith Holler and Günther Knoblich

Saying things with actions – or how instrumental actions can take on a communicative function

Marlou Rasenberg

Language use as joint action: people resolve interactional trouble in multimodal and co-efficient ways

Christophe Heintz and Thom Scott-Phillips

Smoothing coordination: the Ladyginian way and the Gricean way

Janeen D. Loehr

The sense of joint agency in joint music performance: A mixed-methods approach

John Michael and Nikita Kabrel

The Sense of Commitment in Joint Action: A Cross-Cultural Study

Francesca Bonalumi and Christophe Heintz

The commitment loop

Elisabeth Pacherie and Víctor Fernandez-Castro

Commitments and the Sense of Joint Agency

Atesh Koul, Davide Ahmar, Gian Domenico Iannetti and Giacomo Novembre

Origins of interpersonal neural synchrony in spontaneous dyadic behavior

Juan Camilo Avendano Diaz, Riitta Hari and Lauri Parkkonen

Brain oscillations in joint action: Insights from an MEG hyperscanning mirror-game paradigm

Qianliang Li, Marius Zimmermann and Ivana Konvalinka

Exploring Interbrain Synchronization using Two-brain EEG Microstates

Kohei Miyata, Takahiko Koike, Shohei Tsuchimoto, Kanae, Ogasawara, Norihiro Sadato and Kazutoshi Kudo

Sharing action and prior intentions during imitative interaction: a hyperscanning fMRI study

Mini Sharma, Hila Gvirts and Anat Dahan

Graph Theory Approach in Hyperscanning studies -A Review Article

Sara De Felice and Antonia Hamilton

Learning is better with others: evidence from online and face-to-face experiments

Anne Böckler, Eva Landmann, Christina Breil and Leticia Micheli
When it's ok to look away: gaze behavior in conversations shapes social judgments and decisions - depending on context

Georgina Török, Natalie Sebanz and Gergely Csibra
Co-actors integrate the costs of different types of actions in joint action planning

Shaheed Azaad and Natalie Sebanz
Mechanisms to efficiency in joint action

Luke McEllin, Susann Fiedler and Natalie Sebanz
Actions in economic games that contain cues to social preferences influence partner choice

Gray Atherton, Liam Cross, Olga Gali, Sena Beste Ercan, Pamela Heaton, Batuhan Sayis and Narcis Pares
The Moving Mandala: A Mixed Reality Conceptual Replication of Kirschner and Tomasello

Cecilia De Vicariis, Laura Bandini, Giulia Pusceddu, Vinil
Thekkedath Chackochan and Vittorio Sanguineti

Artificial partners to understand joint coordination

Merryn D. Constable, Marta Lagomarsino, Marta Lorenzini,
James W.A. Strachan, Mariacarla Memeo, Arash Ajoudani and
Cristina Becchio

*The social-cognitive rules of robotics: Exploring how to
enhance the usability of robots via principles of joint action*

Ekaterina Ivanova and Etienne A Burde

*Haptic Turing test and learning with robotic and human
partners*

Uma Prashant Navare, Francesca Ciardo, Kyveli Kompatsiari and
Agnieszka Wykowska

*Joint Sense of Agency and Self-Other Integration in Joint
Action: Why Intentionality Matters*

Kyveli Kompatsiari, Abdulaziz Abubshait, Ivana Konvalinka and
Agnieszka Wykowska

*Real and perceived human agency affect interpersonal
synchrony: A mental coordination task*

Basil Wahn, Laura Schmitz, Frauke Nora Gerster and Matthias
Weiss

*Offloading under cognitive load: Humans are willing to
offload parts of an attentionally demanding task to an
algorithm*

Judith Holler

Multimodal addressee responses as tools for coordination and adaptation in conversational interaction

Marlijn ter Bekke, Linda Drijvers and Judith Holler

Do listeners use speakers' iconic hand gestures to predict upcoming words?

Giusy Cirillo, Kristof Strijkers, Elin Runnqvist and Cristina Baus

Effects of shared attention on joint language production across processing levels

Chiara Gambi and Martin J. Pickering

Joint language production and the representation of others' utterances: What next

Anna K. Kuhlen and Rasha Abdel Rahman

Partner-elicited semantic context effects: elusive and (potentially) insightful

M. Fanghella, G. Barchiesi, A. Zazio, M. Pascarelli, A. Battaglia Mayer, M. Bortoletto and C. Sinigaglia

Acting jointly is not just acting side-by-side: An EEG hyper-scanning study

Dimitrios Kourtis, Andrew Low, Christine Knox, Eszter Jardan, Sofia Panagiotakou and Manasa Ashokkumar

With or without you: An EEG study on interpersonal coordination

Quentin Moreau, Vincent Chamberland, Lisane Moses and Guillaume Dumas

Transcranial random-noise stimulation in human-machine social interactions

Vanessa Era, Ugo Pesci, Quentin Moreau, Rachele Pezzetta, Silvia Zabberoni, Antonella Peppe, Alberto Costa, Sara Taglieri, Matteo Candidi and Salvatore Maria Aglioti

Role of the dopaminergic system in interpersonal performance monitoring: behavioral and EEG studies on Parkinson's Disease

Talk session L: Improvisation and
Connection

Wed, 17:00 - 18:00

Yasemin Abra, Mini Sharma, Anat Dahan, Itai Gutman, Hila
Gvirts and Merle Fairhurst

*Investigating the effect of expertise in creative coordination
in groups using a novel zoom-based mirror game*

Inbal Ravreby, Yuval Ritsker and Yaara Yeshurun

People tend to click with others

Daniel C. Richardson, James Allen, Jamie A. Ward and Joseph
Devlin

*JAM (Joint Arousal Measure) Predicts the success of Ads,
Auditions and Movies*

Poster sessions

Poster session 1

Mon, 13:00 - 15:30

Liron Amihai, Elinor Sharvit and Yaara Yeshurun

Can facial mimicry predict decision making?

Nirit Bauminger-Zviely, Yael Estrugo, Einat Karin and Shahar Bar Yehuda

Differences in Joint Action Developmental Trajectories between ASD and TD

Argaman Bell Meir, Liron Amichai, Inbal Ravreby, Yaara Yeshurun

Better Together? Shared Experience Effect on Enjoyment and Facial Expressions During Joint Listening to Audio Clips

Justin Christensen, Jennifer MacRitchie and Renee Timmers

Understanding collaborative music-making in couples living with dementia from a joint action perspective

Victor Chung, Rocco Mennella, Elisabeth Pacherie and Julie Grèzes

The feeling of connectedness during shared emotional experiences predicts the desire of strangers to interact with each other in the future

Liam Cross, Chia-huei Tseng and Gray Atherton

Synchronizing in a virtual world. Can Virtual Reality paradigms solve some of the pragmatic problems with social synchrony research?

Cecilia De Vicariis, Laura Bandini, Vinil Thekkedath Chackochan, Eleonora Ravaschio and Vittorio Sanguineti

Partner representation and decision-making in joint action

Chiara Fini, Vanessa Era, Giovanna Cuomo, Mattia A. Gervasi, Ilenia Falcinelli, Matteo Candidi, Claudia Mazzuca and Anna M. Borghi

Chatting About Different Subtypes of Abstract Concepts Differently Modulates Closeness Among Interlocutors

Felix J. Götz and Gesine Dreisbach

Follow My Lead! Followers' Reliability Modulates Leader's Goal Persistence in a Novel Joint Goal-Setting Paradigm

Gregorini, C., De Carli, P., Parolin, L., Petilli, M., Konvalinka, I. and Preti, E.

Stable asynchrony? Associations between borderline personality traits and interpersonal asynchrony

Christophe Heintz and Liubov Voronina

Joint history of play provides means for coordination

Akifumi Kijima, Keito Fujioka, Kentaro Go and Hiroyuki Shima

Rigorous action synchrony compromised in a virtual space without the risk of physical body collision

Jinyu Li and Leonardo Lancia

Are you sure it's your voice? Exploring the relations between phonetic alignment and sense of agency

Rui Liu, Aliaksandr Dabranau and Ivana Kovalinka

Modulation of broadband EEG on communication dynamics

Jordi Manuello, Camilla Maronati, Riccardo Guidotti, Matilde Rocca and Andrea Cavallo

Developing a new computational framework for quantitative analysis of motor styles

Camilla Maronati, Jordi Manuello, Luigi F. Cuturi, Riccardo Guidotti and Andrea Cavallo

I move like you, I better read you: the role of 'motor distance' in action understanding

Francesca Miti, Jlenia Toppi, Ciaramidaro Angela, Laura Astolfi, Cristina Iani and Sandro Rubichi

EEG hyperscanning in a joint Simon task: a new approach to study joint action

Lena Nalbandian, Miles Tufft and Daniel Richardson

The effects of an interpersonal social context on attention in a joint visual search paradigm

Julius Rennert and Felix J. Götz

Obedience to Authority as an Asymmetrical Joint Action

Luke Daniel Ring, Linus Joakim Backström and Anna Zamm
Aarhus University

Low-latency real-time sonification as a novel paradigm in joint action research

Nejra Rizvanović and Natalie Sebanz

Does joint action coordination affect expectations of over-imitation in adults?

Maor Rosenberg and Lior Noy

Creative Exploration and Secure Attachment

Laura Schmitz, Mariacarla Memeo, Andrea Cavallo, Bahador Bahrami and Cristina Becchio

How sure are you? Kinematic readout of confidence in collective decision-making

Giulia Scorza Azzarà, Joshua Zonca, Francesco Rea, Joo-Hyun Song and Alessandra Sciutti

Can a Joint Action with a Robot Lead to Shared Body Representation?

Giulia Siri, Abdulaziz Abubshait, Davide De Tommaso, Pasquale Cardellicchio, Alessandro D'Ausilio and Agnieszka Wykowska

Motor inhibition in joint action tasks with humans and robots

Andrii Smykovskyi, Marta M. N. Bienkiewicz, Stefan Janaqi and Benoît G. Bardy

Impact of Emotion on Spontaneous and Intentional Interpersonal Synchronisation

Marcell Szekely, Stephen Butterfill and John Michael

Effort-Based Decision Making in Joint Action: Evidence of a Sense of Fairness

Hoang Anh Tran, Jorden A. Cummings and Janeen D. Loehr

Experiences of united agency in joint action: Where, when, and why?

James P. Trujillo, Rebecca M.K. Dyer and Judith Holler
Differences in Partner Empathy are Associated with Interpersonal Kinetic and Prosodic Entrainment During Conversation

Enrico Vescovo, Pasquale Cardellicchio and Alessandro D'Ausilio
Join the action: top-down and bottom-up information modulate different neurophysiological indexes

Basil Wahn, Leda Berio, Matthias Weiss and Albert Newen
Try to see it my way: Humans Take the Level-1 Visual Perspective of Humanoid Robot Avatars

Michael Wilby and Anna Strasser
Human-machine interactions as joint actions and their moral consequences

Dalila Albergo, Nathan Foster, Andrea Cavallo, Noemi Montobbio, Caterina Ansuini, Francesca Battaglia, Lino Nobili, Cristina Becchio and Stefano Panzeri

Intention reading from movement kinematics: a training protocol

Laura Bandini, Cecilia De Vicariis and Vittorio Sanguineti

Predictive processes and action strategies in competitive and cooperative joint action

Dilan Çabuk, Çağlar Akçay and Terry Eskenazi

Survival Processing Boosts Memory for Partner's Information in Shared Tasks

Miao Cheng, Jin Liu, Shoi Higashiyama, Yoshifumi Kitamura, Satoshi Shiori and Chia-huei Tseng

Context Effect on Embodied Emotions: A Dual-Dimensional (Valence and Arousal) and Dual-Direction (Assimilation and Contrast) Analysis

Justin Christensen, Shawn Kauenhofen, Jennifer Lang, Shelley Peacock, Jennifer Nicol and Janeen Loehr

Musical technology for examining joint action in couples with dementia through duet playing

Giovanna Cuomo, Antonio Pio Afragola, Gökhan Karcı, Vanessa Era and Matteo Candidi

Interpersonal Motor Interactions Remap Visuo-Tactile Integration

Alper Demircan

Language differences do not prevent Joint Memory Representations

Martin Dockendorff, Laura Schmitz, Cordula Vesper and Günther Knoblich

*Linking communicative modulations to distal goals: motor-
iconicity or arbitrary mappings?*

Sara F. Abald, Félix Bigand, Roberta Bianco, Peter E. Keller and Giacomo Novembre

*On the role of ancillary body movements in joint music
making and interpersonal synchronization*

Kassandra Friebe and Günther Knoblich

*Co-representation of an imagined partner's task; the effect
of imagined joint action and facial trustworthiness*

Thomas Ganzetti and Günther Knoblich

*Affective observation: generalization of negative emotional
expressions targeting action performances*

Tiam Ghorab, Luke McEllin and Natalie Sebanz

The Role of Individual Considerations in Joint Decision-Making

Felix J. Götz and Gesine Dreisbach

*Follow Me - follow You? Interacting with a Human But Not a
Computer Motivates Conflict Adaptation in Interindividual
Response Conflict*

Hüttner, N., Müller, F. and Cañal-Bruland, R,

*Birds of a feather excel together? The impact of dyadic
motive fit on performance in a joint action task*

Adrian Kempf

Examining the association between synchronization and social cohesion through the lens of creativity. An empirical study

Vjeran Keric, Katrina McDonough, Natalie Sebanz and Patric Bach

Influence of expectations of co-efficiency on action prediction

Christian Kliesch

Postnatal dependency and its contribution to joint action understanding

Alexis Le Besnerais, Elise Prigent and Ouriel Grynszpan

Agency and social affordance shape visual perception

Li, M. S, Tomczak, M, Elliott, M, Witek, M, Bradbury, A, Goodman, T, Abdlkarim, D, Di Luca, M, Hockman, J and Wing, A. M

Tempo Change and Leadership in Ensemble Synchronisation: A Case Study

Ieva Lukošūnaitė, Ágnes Kovác, Shaheed Nizam Azaad and Natalie Sebanz

The Importance of Action Observation in Perspective Taking

Sara Mazzini, Judith Holler, Peter Hagoort and Linda Drijvers

Investigating inter-brain synchrony during (un-)successful face-to-face communication

Uma Prashant Navare, Veerle L.N.F. Hobbelenk and Agnieszka Wykowska

Predictive action planning and agency during joint action in human-human and human-robot interaction

Oriana Pansardi, Andrea Cavallo, Giacomo Turri, Stefano Panzeri, Alan Sanfey and Cristina Becchio

The Vigor of Punishment

Pesci, U.G., Spagnuolo, V., Noppeney, U. and Candidi, M.

The influence of social interactions on visuotactile causal and perceptual inference

Jesper Rørvig, Tania Couto, Liberty Severs, Ana Paiva, Miguel Faria, Filipa Correia, Raquel Sofia Oliveira and Anna Ciaunica

Embodied Joint Agency in Human - Robot Interaction

Arianna Schiano Lomoriello, Alejandro Luis Callara and Ivana Konvalinka

Reading Between the Heartbeats: Exploring Self and Other Interoceptive abilities in Inferring Others' Bodily Signals

Peter Thestrup Waade, Julian Zubek, Anna Zamm, Olivia Foster Vander Elst, Cordula Vesper, Kristian Tylén, Rebekah Bagglini, Luke Ring, Fernando Rosas and Joshua Bamford

Synchrony, synergy and sense of joint action in naturalistic social coordination: the case of Lindy Hop partner dancing

Alice Tomassini and Alessandro D'Ausilio

The 'microstructure' of interpersonal neurobehavioral coordination

Georgina Török, Gergely Csibra and Natalie Sebanz

Co-efficiency as a potential focal point in coordination problems

Miles R. A. Tufft, Mei Nakamura, Iwona K. Zak and Anna K. Kuhlen

Towards a Mechanism of Semantic Interference Removal in the Joint Picture-Word Interference Paradigm

Pavel V. Voinov, Yuko Hattori and Ikuma Adachi

Do chimpanzees (Pan Troglodytes) form co-representations in a collective enumeration task?

Elisa Wiedemann, Thomas Wolf, Günther Knoblich and Natalie Sebanz

Central European University, Vienna, Austria

Does interpersonal synchrony reduce self-other distinction?

Chen Zheng and Barbara Tversky

Coordinating Joint Action in a Novel Complex Real-world Task

Zijun Zhou, Justin Christensen and Janeen Loehr

Interbrain synchronization underlying people's sense of joint agency during musical joint action

Abstracts

(in alphabetical order)

Investigating the effect of expertise in creative coordination in groups using a novel zoom-based mirror game

L

Yasemin Abra^{1,2}, Mini Sharma³, Anat Dahan⁴, Itai Gutman³, Hila Gvirts³ and Merle Fairhurst²

¹LMU Munich, Munich, Germany

²Centre for Tactile Internet with Human-in-the-Loop” (CeTI) of Technische Universität Dresden, Dresden, Germany

³The Department of Behavioral Sciences, Ariel University

⁴Department of Software Engineering, Braude Collage

From surgery to group music making, humans coordinate in groups not only for functional purposes, but to achieve greater creative potential. Although the dynamics underpinning creative coordination have received attention in recent years, no previous research has investigated the effect of expertise on how we interact within a group. In this study, we investigate how coordination and complexity of movement in a Zoom-based Mirror Game are influenced by expertise. Using Dynamic Time Warping (DTW) to measure the time-series similarity of dyads within groups of eight novices or experts, we compare interpersonal coordination with movement complexity and novelty (Shannon’s Entropy). We investigate how the combination between coordination and complexity affects how we feel about others. Experts show higher coordination and lower complexity than novices. Additionally, regardless of expertise, higher DTW predicts lower mood. Moreover, novices show less synchrony and greater entropy overall than experts. Higher complexity and lower coordination was found to predict better cohesion with others in experts, whereas in novices, the reverse relationships were observed. Together, this novel approach to studying groups in an online setting, identifies a distinct relationship in experts and in novices between coordination and movement complexity, a possible proxy for creativity.

Intention reading from movement kinematics: a training protocol

P2

Dalila Albergo^{1,2}, Nathan Foster¹, Andrea Cavallo^{3,1}, Noemi Montobbio^{1,4}, Caterina Ansuini¹, Francesca Battaglia^{5,1}, Lino Nobili^{5,6}, Cristina Becchio^{7,1} and Stefano Panzeri^{8,1}

¹Istituto Italiano di Tecnologia, Genoa, Italy

²Center for Mind/Brain Sciences, University of Trento, Rovereto, Italy

³Department of Psychology, University of Turin, Italy

⁴Dipartimento di Scienze della Salute (DISSAL), Università di Genova, Italy

⁵Child Neuropsychiatric Unit, G. Gaslini Institute, Genoa, Italy

⁶Department of Neurosciences, Rehabilitation, Ophthalmology, Genetics, Maternal and Child Health (DINO GMI), University of Genoa, Italy

⁷Department of Neurology, University Medical Center Hamburg Eppendorf (UKE), Hamburg, Germany

⁸Department of Excellence for Neural Information Processing, Center for Molecular Neurobiology, University Medical Center Hamburg Eppendorf (UKE), Hamburg, Germany

Small variations in movement kinematics transmit specific intention-related information.

In previous studies, we found that human observers are able to read some, but not all, of this information.

Here, we examined whether the ability to read intention information from movement kinematics can be improved with training.

10 neurotypical adults joined the study. Participants completed a training consisting in a one-interval two-alternative forced-choice intention discrimination task (discriminate the intention of observed reach-to-grasp-to-pour and grasp-to-drink movements), followed by a visual feedback after each trial, in the form of a video showing the full action sequence. Participants' intention discrimination ability was assessed before (pre-test) and after (post-test) the training session. No feedback was provided during the pre- or post-test. We used two non-overlapping sets of stimuli with equally representative kinematic features for the two intentions, separately, for testing and training.

Pilot data revealed a moderate improvement of intention discrimination abilities after training.

Previous studies have shown that children with Autism Spectrum Disorders (ASD) have difficulties in extracting the correct intention information from movement kinematics. If replicated in a larger sample of participants, the current results may be useful to inform the design of novel training protocols that promote intention reading in ASD.

Can facial mimicry predict decision making?

P1

Liron Amihai, Elinor Sharvit and Yaara Yeshurun

Tel Aviv University

Facial expressions are one of the most prominent non-verbal cues revealing individual's mental states. During face-to-face interactions, people tend to mimic each other's facial expressions. This mimicry plays an important role in successful social communication and is linked to empathy, theory of mind and emotional contagion.

In the current study, we set out to test whether facial expressions, and specifically facial expressions' mimicry, can be used to predict individual's subsequent decision. Thirty dyads participated in a naturalistic social decision-making task. In each trial, participants read or listened to short synopses describing movies and chose which of the movies they would like to watch. We measured their facial expressions using sEMG printed electrodes.

Preliminary results revealed that speaker-listener facial synchronization predicted the chosen story with an accuracy of 0.705 ($p = 0.006$). We intend to (i) analyze the joint action of blinking, and (ii) use advanced machine learning tools to further investigate the data.

Our preliminary results suggest that the joint action of facial mimicry, rather than the individual's facial expressions of emotion per se, has a communicative function that can predict people's preferences throughout a conversation.

The Moving Mandala: A Mixed Reality Conceptual Replication of Kirschner and Tomasello

H

Gray Atherton¹, Liam Cross¹, Olga Gali², Sena Beste Ercan², Pamela Heaton³, Batuhan Sayis² and Narcis Pares²

¹Edge Hill University

²Pompeu Fabra University

³Goldsmiths University of London

Synchronous movement between individuals has been shown to increase pro-sociality, such as closeness and generosity. To date, synchrony research tests these effects using a variety of movement tasks, including musical and non-musical coordination. However, musical versus non-musical synchrony may have separable pro-social effects. To test this, we immersed 60 children in a Mixed Reality full-body interactive system called the ‘Moving Mandala’ where they moved asynchronously, synchronously with visual cues, or synchronously with musical cues. We then tested the pro-social effects of the task with an economic game and proxemics. Results showed that those who had moved to music were significantly more likely to position themselves more closely to other children in the proxemics task. In contrast, those who had moved synchronously without music were more likely to give generously in the economic game compared to the asynchronous condition. The implications of these findings are discussed.

Brain oscillations in joint action: Insights from an MEG hyperscanning mirror-game paradigm

G

Juan Camilo Avendano Diaz, Riitta Hari and Lauri Parkkonen

Department of Neuroscience and Biomedical Engineering, Aalto University, Espoo, Finland

We investigated the neural and behavioral signatures underlying action observation, leader-follower coordination and joint improvisation in interacting dyads. We present data from 10 pairs of participants performing a 1D finger-movement mirror game while magnetoencephalography (MEG) was simultaneously recorded from both subjects and the related finger kinematics was tracked using accelerometers. We observed that alpha band source-level power in widespread brain regions were reduced in social (interaction or observed action) compared to individual (isolated) action. This reduction in alpha was restricted to occipital areas when contrasting interaction vs. observed action. We also obtained a widespread beta suppression in interaction compared to individual action (observed or in isolation), and a left TPJ suppression when comparing observed vs. isolated action. Across interactive conditions, we found that rolandic theta and superior parietal beta were stronger in followers than leaders, while occipital beta was stronger in leaders than in joint improvisers. Finally, when examining intra-brain functional connectivity, we observed a reduction in the alpha-band-mediated connectivity (assessed by weighted phase lag index) while interacting, compared to individual (isolated) action. This reduction involved occipital, temporal, parietal and frontal brain regions. Our results contribute to the understanding of the role of brain oscillations on interpersonal motor interactions.

Shaheed Azaad and Natalie Sebanz

Central European University, Austria

Studies investigating efficiency in joint action have found that individuals will choose a more effortful action for themselves or their partner to minimise the total effort expenditure for the dyad. This finding is often taken as evidence that actors intentionally seek to minimise effort costs to the dyad. However, it is unclear to what extent confounded visual cues - like distance - might also contribute to decision-making. In this project, we sought to test whether efficient decisions might be based on such heuristics. In a touch-screen computer task, dyads chose to drag objects to one of two locations: 1) a closer location that would require joint dragging or 2) a farther location that would require a solo movement. Critically, we varied the relative distance between these locations so that the joint option would require either less, more, or the same, expenditure (in total) than the solo option. Participants tended to choose the closer, joint option irrespective of the relative effort costs. Instead, the percentage of trials in which actors chose to act jointly only decreased when the two goals were equidistant. We conclude that joint efficiency might be, at least in part, achieved through heuristic-based decision-making.

Predictive processes and action strategies in competitive and cooperative joint action

P2

Laura Bandini, Cecilia De Vicariis and Vittorio Sanguineti

Department of Informatics, Bioengineering, Robotics and Systems Engineering, University of Genoa, Italy

Humans rely on optimality principles to make decisions and generate movements, and use Bayesian principles to predict state and evolution of the environmental features relevant to performance. In individual movements, this has been tested by manipulating the environment and the amount of sensory information and looking at changes in the resulting actions. Test of Bayesian principles in joint action scenarios also requires discriminating partner representations.

We designed a two-player scenario where an ‘attacker’ and a ‘defender’ interact through a dual haptic interface according to three variants (pass, intercept, dodge). Attackers shoot the ball toward (pass, dodge) or away (intercept) from the defenders. Defenders either catch (pass, intercept) or avoid (dodge) the ball. We varied sensory information (ball/partner position uncertainty) and introduced sensory (ball direction) and motor perturbations (springs connecting players to different workspace regions). We investigated whether the players develop internal representations of their opponents; how these are used to control their actions; and how players adapt their strategies to perturbations and changes in task requirements. We contrasted experimental observations with predictions of a computational model based on game theory (action control) and Bayesian principles (perception). We found that the players accurately account for their opponents when selecting their actions.

Differences in Joint Action Developmental Trajectories between ASD and TD

P1

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Joint action (JA) is an integral part of any social interaction with a partner. This study examined differences in JA developmental trajectories between eighty-four Autism Spectrum Disorder without Intellectual Disability (ASD-WoID) (IQ=104.23, CA=11.0) and sixty-four Typically Developing (TD) (IQ=114.53, CA=11.7) youths in three developmental age groups (early-childhood, pre-adolescence and adolescence), matched according to IQ, Chronological Age (CA), and sex.

Four JA tasks were implemented in peer-dyads paired according to study group, IQ, CA and sex. Mirroring a partner's body and hand movement and side-to-side walking and complementing his movements when crossing an imaginary narrow corridor and playing an imaginary soccer game generated four coordinated movement scores, calculated as the ratio between the dyadic co-occurring and each participant's own movement percentages.

TD outperformed ASD group for all JA-tasks. Main effect of age was found for all four JA-tasks when older outperformed younger, and for walking and soccer JA-tasks only, pre-adolescents surpassed early-childhood participants. GroupXage interaction demonstrated that study groups differ in their JA developmental trajectories, with only TD showing improvement with age in JA-mirroring (walking) and JA-complementing (corridor) tasks.

Results emphasize the need to include motor coordination into social intervention to improve children with ASD's involvement in peer interaction.

Short-term duet interventions affect subsequent synchronization and social interaction

C

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The presence of a partner can influence individuals' synchronization performance as well as social connection with the partner. We manipulated the quality of the synchronization in intervention conditions to address the causal relationship between temporal synchrony and perceived social interaction. Pairs of musician and non-musician participants performed a Turn-taking task, in which they alternated producing a melody in synchrony with a metronome. In two Intervention conditions, participants attempted to synchronize with their partner, either with normal auditory feedback or with randomly placed delayed feedback. The Turn-taking condition was repeated after each intervention. We modelled participants' performance in the post-intervention Turn-taking conditions using delay-coupling oscillator models. After each intervention condition, participants completed a questionnaire about social connectedness with their partner. Results showed that partners' asynchronies were larger following the Delayed feedback Intervention. Tapping variability was larger following the Delayed feedback Intervention for non-musicians who had the Delayed feedback intervention first. This increased tapping variability was reflected in reduced coupling strength in the delay-coupling model. Finally, ratings of connectedness with their partner were reduced after the Delayed feedback Intervention. These findings suggest that Turn-taking synchronization performance as well as social connectedness are altered following short interventions that disrupt synchronization with a partner.

Better Together? Shared Experience Effect on Enjoyment and Facial Expressions During Joint Listening to Audio Clips

P1

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Sharing experiences with others can amplify one's emotional response to an experienced event. In this work, we tested how joint listening with a friend (Zoom) shapes enjoyment, and explored the role of facial expressions in driving this effect. In Study1, participants (N=184) listened to short audio-clips of different (humoristic and non-humoristic) contents alone or with a friend. We found that enjoyment was affected by the joint listening in a content-dependent manner; one type of humor (knock-knock jokes) was more enjoyable with a friend than alone, whereas another (live stand-up) was less enjoyable with a friend. However, listening together with a friend amplified the intensity of happy facial expressions participants expressed, regardless of how much they enjoyed the clip. Moreover, friends were synchronized in their facial expressions during the joint listening. Intriguingly, those effects of co-experiencing on enjoyment and facial expressions disappeared when participants listened to the audio-clips with their eyes closed. In Study2, we tested whether these opposite enjoyment patterns were due to different expectations. We found that the presence of a friend served as a "social feedback loop"- amplifying the gap between enjoyment-expectation and experienced-enjoyment. Overall, our findings suggest that facial expressions play a vital role in communicating with others.

Mental effort and expressive interaction in expert and student string quartet performance

C

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Ensemble musicians use multimodal information flow when coordinating their performances. How do ensembles adapt when information flow is disrupted? This study investigated how classical string quartets respond to performance constraints that disrupt their established patterns of audiovisual interaction. An expert quartet (DSQ) and a student quartet (BSQ) performed a Haydn piece five times without an audience, and once with audience, as their seating configuration was manipulated to disrupt visual communication. Audio, head motion, eye-tracking/pupillometry, and heart rate data were collected. The DSQ maintained their sound quality, body interactivity, and high cardiac synchrony across conditions, but showed smaller pupil sizes during visual disruption, suggesting reduced engagement. The BSQ moved less and showed reduced cardiac synchrony when they could not see each other, but their pupil sizes were similar across conditions. The quartets spent a similar percentage of performance time watching their co-performers. The DSQ does not seem to require visual interaction to maintain high performance quality, though the musicians do interact visually when given the opportunity. This visual interaction stimulates greater mental effort, perhaps reflecting increased social engagement. Cardiac synchrony seems to relate to a sense of shared absorption, which is more easily disrupted for the students than the experts.

When it's ok to look away: gaze behavior in conversations shapes social judgments and decisions - depending on context

H

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Humans' sensitivity to conspecifics' gaze is often considered a core component of successful interaction. However, besides basic effects on attention allocation, the role of looking behavior in communication and cooperation remains poorly understood. I would like to present a few studies using an online conversation paradigm (Zoom-task) that addressed how perceived gaze behavior shapes social evaluation and decision-making. In these studies, listeners of dyadic conversations were visible and displayed various forms of gaze behavior (e.g., according to gaze direction) while listening to a speaker who told either neutral or negative personal experiences (emotional context). After each observed conversation, participants evaluated the listeners and played incentivized interactive games with them (Trust Game, Dictator Game). We found decisions (trust, generosity) to be less favorable when the listeners' gaze was averted - which was fully driven by the more negative evaluation of the listeners. Critically, effects of gaze direction were modulated by emotional context: When listening to negative narrations, averted gaze, especially when averted downward and when shifting occasionally, had a positive impact on judgments and behavior. This pattern emphasizes that context-dependency and semantic flexibility is what makes gaze so golden.

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One of the most efficient means to induce cooperation involves committing and trusting that commitments will be respected. In this socio-cognitive process, people cooperate when they have good evidence that the cooperative venture will be beneficial. But how do people recognise situations in which it is beneficial to rely on their social partners? What evidence do people take into account? We answer these questions by describing the cognitive processes of belief formation about what others will do as well as these others' motivations. We argue that they feed each other and thus constitute a "commitment loop". The commitment loop involves the following socio-cognitive events: (1) Actor A forms the belief that actor B relies on them to do X; (2) Actor A is therefore motivated to do X; (3) Actor B forms the belief that actor A will do X; and (4) Actor B is therefore motivated to rely on A doing X; and so on.

The looping process explains why very minimal evidence about one's commitment is sufficient for people to actually commit and trust. The process is such that, as soon as one enters the loop, trust and commitment reinforce each other. We will discuss this and other consequences of this socio-cognitive theory.

"United we stand, divided we fall": intertwining as evidence of joint actions in plants

B

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The term “joint action” refers to actions in which two or more individuals coordinate in space and time to reach common goals. In recent years, major advances in understanding the processes involved in joint action have been made by investigating perception and action in social context. An aspect which remains unsolved is whether aneural organisms such as plants can share a goal and act in concert. To fill this gap, we examined this issue in the context of two pea plants growing intertwined when there is a need to climb but a potential support is not present. Kinematical analysis of their movement revealed a synchronized pattern of movement. They tend to coordinate temporal aspects concerned with velocity and acceleration profiles as demonstrated via correlational analyses. We contend that plants can share common goals and implement cooperative actions, even in the absence of a brain. We explain this phenomenon in the light of action-oriented theories that move the cognitive processes outside the brain and conceive them as deeply rooted in an organisms’ interaction with the environment.

The emergence of physiological synchrony during joint action and its association with task-related motor parameters and dyadic personality traits

A

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Physiological synchrony, the temporal alignment of biological states between individuals, has been repeatedly observed during joint action. Nevertheless, it is unclear whether its occurrence is linked to specific features of dyadic motor behaviour and/or to individual differences in empathic traits.

To investigate these aspects, we recorded the heart rate of forty same-gender dyads engaged in a joint action task requiring to grasp two bottle-shaped objects as synchronously as possible. From the task, we extracted several motor parameters, while dyadic personality traits were quantified by averaging the two members' scores at empathy questionnaires. Physiological synchrony was indexed as the maximum cross-correlation observed between the two heart rate time series.

Results showed that dyads who moved faster and synchronized more the beginning of their movements also aligned more at the physiological level. In addition, dyads with higher average empathy levels showed higher synchronization in starting their movements, increased physiological synchrony and reported stronger feelings of “being on the same wavelength” during the task.

Overall, our data suggest that both individual dispositions and task-related motor features can foster physiological synchrony during joint action. Moreover, empathic individuals might get more easily “in synch” at the physiological level because of their ability to align behaviourally.

Survival Processing Boosts Memory for Partner's Information in Shared Tasks

P2

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Processing information in a survival context increases later retrieval performance. We investigated whether this survival processing effect would be seen for information encoded by another individual in a shared task. Previous research showed that in shared tasks, participants co-represent and encode their partner's information even when it's irrelevant. We predicted survival processing would lead to enhanced co-representation of partner's information. Forty-seven participants rated words for their usefulness either in a survival scenario or a moving scenario, both alone and in dyads with a confederate. Participant and the confederate were each assigned one of the three semantic categories and asked to respond to words from that category. Words from the third unassigned category were ignored. In a surprise recall test participants in both survival and moving groups recalled more items from the category of their task partner than items from the unassigned category, indicating task co-representation. Crucially, this effect was found larger in the survival group: participants in the survival group remembered their partner's items as much as those of their own. This increased task co-representation in the survival scenario may point to an "information hoarding" strategy which may be adaptive if two individuals need to jointly act to survive.

Context Effect on Embodied Emotions: A Dual-Dimensional (Valence and Arousal) and Dual-Direction (Assimilation and Contrast) Analysis

P2

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Context plays a crucial role in shaping emotion perception. Previous research has demonstrated the impact of contextual factors on facial emotions. However, the extent to which bodily expressions of emotions are influenced by context remains unclear. In this study, we presented two emotional biological motions side by side and examined how perceived intensity of target emotion (anger, joy, sadness) was influenced by the context. We investigated the contextual effect along two dimensions: arousal (anger vs. sadness) and valence (anger vs. joy). Additionally, we explored whether the effect followed a direction of assimilation or contrast.

We recorded the bodily expressions of anger, joy, sadness, and neutral emotions from professional performers using a motion capture system and transferred them to biological motion stimuli, moving point-light displays that express body movements. In the experiment, 22 participants rated the intensity of the target emotions when presented alongside one of the other three emotions as context.

Our findings indicate that anger and sadness were perceived stronger when paired with the context stimulus of the same emotion rather than that of neutral emotion. Additionally, we observed contrast effect in only negative emotions along the arousal dimension, whereby the angry context made the sad target sadder, and the sad context made the angry target angrier. This study offers a novel perspective on how contextual factors modulate embodied emotions.

Understanding collaborative music-making in couples living with dementia from a joint action perspective

P1

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People living with dementia often undertake joint actions with others in everyday tasks. This is evidenced in the daily activities of couples living with dementia that would commonly be undertaken by one person but are now being done as a joint activity (e.g. joint managing of hygiene or eating). However, people living with dementia are seldom considered in joint action research, and joint actions are rarely investigated in dementia research. Using a joint action perspective, we see that asymmetrical joint actions of couples with dementia are not something performed by an active caregiver on a passive partner living with dementia. It also helps us examine how musical activities benefit couples with dementia. Collaborative music-making, with its lowered demands on linguistic and narrative resources, can enable people living with dementia to flourish by reducing their reliance on others, demonstrating their agency both to themselves and their partner in this shared experience. We propose that examining these activities from a joint action perspective i) enriches our understanding of the benefits offered to people living with dementia, ii) enables us to support feelings of agency through the use of technology, and iii) enriches our understanding of joint actions more generally.

Musical technology for examining joint action in couples with dementia through duet playing

P2

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This poster describes the development of musical joint action technology for therapeutic and research applications. The design process began with the e-music boxes introduced by Novembre et al. (2015) and used to study musical joint action in the lab. Using a multi-phase iterative design approach with an emphasis on participatory design methods, we engaged participants to direct development in a way that facilitated intuitive engagement for people living with dementia and with no prior musical expertise. Like the e-music box, the Music Memory Makers Duet System transforms cyclical movement into musical output, with rotation speed controlling the tempo of the music. In addition, we incorporated ideas from music reminiscence therapy, allowing the couple to perform meaningful songs from their shared history. Source separation tools were applied to make duets from recorded audio; a visual interface was designed to better support multimodal interaction; and a smoothing function was added to links between participants' movements and their perceptual outcomes. In using the devices, many participants experienced a support "we" mentality and enjoyed synchronizing their parts with each other. This system could be valuable for supporting couples living with dementia and for adding their voices to further our understanding of joint action.

The feeling of connectedness during shared emotional experiences predicts the desire of strangers to interact with each other in the future

P1

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Emotional gatherings (e.g., protests, demonstrations, music festivals) are paramount events for societies, because they fuel social bonds and collective action on a large scale (Páez & Rimé, 2023; Pizarro et al., 2022). Accordingly, experiments showed that shared emotional experiences, such as watching videos together, led participants to experience more intense emotions (Shteynberg et al., 2014), which in turn predicted their feelings of closeness (Rennung & Göritz, 2015). Could shared emotional experiences also account for individuals' motivation to interact with each other? We hypothesized that experiencing connectedness during shared emotional experiences would predict willingness-to-interact. To test our hypothesis, we recruited 56 pairs of unacquainted individuals who jointly watched emotion-eliciting videos. We asked participants to report their desire for future interaction (Coyne, 1976) at the beginning and end of the experiment, as well as their feeling of connectedness (Gabriel et al., 2019) after each video. The results confirmed that feeling more connected during the videos predicted increased desire for future prosocial interaction (partial mediation), which suggests the importance of shared emotional experiences for large-scale cooperation. Finally, we will propose ideas for a new study testing the effect of shared emotion on other aspects of joint action, namely motor coordination and strategic cooperation.

Impact of errors on temporal adaptation and anticipation mechanisms during musical joint action

C

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During complex social interactions like musical ensemble performances, people succeed in “staying in the loop” thanks to intentional and planned interpersonal coordination. This is particularly relevant when during a shared task, our partner commits an error. The present study aimed to evaluate how a leader-follower pair of individuals adapt their performance to reduce the negative impact of errors on coordination during a musical task. To this end, we asked pairs of participants to perform a musical sequence production task in three different conditions, across which we manipulated the frequency of error occurrence (0 vs. 60% vs. 30%). Each member of the pair was assigned to either the role of leader or follower. The leader had access to a visual metronome indicating the correct tempo and sequence of keys, including ‘errors’, to be played during the tasks. The follower was instructed to play the correct sequence of keys keeping the tempo of the leader. Results showed that for sequences including errors the performance was characterized by lower variability in asynchrony and higher phase correction compare to correct sequences. Results are interpretable in terms of top-down control over sensorimotor mechanisms of coordination.

Effects of shared attention on joint language production across processing levels

J

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Shared attention across individuals is a crucial component of joint activities, modulating how we perceive relevant information. In the present study, we explored shared attention in language production and memory across separate representation levels. In a shared go/no-go task, pairs of participants responded to objects displayed on a screen: One participant reacted according to the animacy of the object (semantic task), while her partner reacted to the first letter/phoneme (phoneme-monitoring task). Objects could require a response from either one participant, both participants, or no-one. Only participants assigned to the phoneme-monitoring task were faster at responding to joint than to alone trials. Results from a memory recall test showed that for both partners recall was more accurate for those items to which the partner responded (relative to those responded by no-one), but even more so for jointly responded items. Our findings suggest that shared attention boosts language processing and encoding, but also that shared attention in language is selective and depends on the linguistic feature a partner attends to.

The social-cognitive rules of robotics: Exploring how to enhance the usability of robots via principles of joint action

I

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To enhance usability, how can we develop collaborative robots that align with human physical and cognitive preferences? In human-human interactions, social conventions create expectations for action and act as heuristics in action planning. As a result, adhering to social conventions provides an opportunity for fast and effective interactions. We explored the extent to which participants facilitated the physical efficiency of a joint action whilst handing an object to a co-agent in both human-human and human-robot interactions. Facilitatory behaviour was observed: Participants rotated the handle toward the robot, albeit not to the same extent as a human receiver. When receiving an object from the robot, the participants adapted well regardless of the handover strategy. Nevertheless, results indicated that if a robot facilitates the action of a co-actor by balancing the aggregate physical costs of the joint action, then perceptions of the interaction are enhanced. This initial work demonstrates the importance of considering human physical, social and cognitive tendencies in developing collaborative robot behaviours to improve the technology's usability and acceptability.

Synchronizing in a virtual world. Can Virtual Reality paradigms solve some of the pragmatic problems with social synchrony research?

P1

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Researching the pro-social effects of synchrony suffers from certain pragmatic issues that are quite difficult to overcome, such as ensuring the required degree of coordination between participants, scheduling multiple participants in a session, especially when trying to bring together individuals from different social groups.

Virtual Reality (VR) offers an elegant solution to overcome these problems and affords new possibilities that would not be possible in the real life. We have developed a VR application to manipulate the environment in which coordination takes place, the number and type of agent with whom participants are coordinating with and the type and degree of coordination achieved between participant and their virtual partner.

Four studies with 70 participants in each have evaluated the social consequences that follow virtual drumming with a range of avatars (same race, another race, another species and a robot). In each study participants spent five minutes drumming to a popular song, guided by a metronome cue. In front of them a virtual avatar drummed either synchronously or out of time with them. Participants ITI's with both the beat and the agent were recorded. Following this participant responded to a range of social tasks designed to evaluate their perceptions and behaviour toward target individuals / groups.

Interpersonal Motor Interactions Remap Visuo-Tactile Integration

P2

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Expansions of the Peri-Personal Space during individual action execution have been indexed by measuring cross-modal interferent effects of distant visual cues over the ability to detect tactile stimuli that are spatially congruent or incongruent with the end-location of one's action. Here we studied whether these effects are modulated by the presence of a partner with which participants need to coordinate in a joint-grasping task as a function of the nature of the interaction requiring or not to predict the movements of a partner. Eighteen participants were asked to grasp an object synchronously with a facing virtual partner by performing OPPOSITE/SAME movements to those of the partner (FREE condition) and to detect a tactile stimulus on their finger while spatially IN/CONGRUENT visual cues with the participants' end-location appeared on the to-be-grasped object. As a control condition (GUIDED), participants were instructed to synchronize with the partner and to ignore the target position of the partner action. The classical interferent effect of spatially incongruent visual cues over tactile detection was abolished selectively when participants needed to predict the movement of the partner (FREE) during OPPOSITE interactions showing that visuo-tactile integration is remapped by the rules of interpersonal interactions.

Learning is better with others: evidence from online and face-to-face experiments

G

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What is the role of social interaction in learning? We designed a paradigm where participants learned a series of unknown facts in different (social) learning contexts. First, we show results from two experiments (N=51) conducted online, demonstrating that people learned better in live-video calls compared to yoked recorded videos. Seeing the face of the teacher improved learning specifically in live but not recorded sessions. These results replicated in population with Autistic Spectrum Condition (N=128). Second, we present a large functional Near Infra-Red Spectroscopy (fNIRS) hyperscanning study, where 27 dyads (N=54) learned in conversation with their partner, alternating roles between teacher and student, while audio, video, head-movement, physiology and brain data was collected. Results show that brain-to-brain coherence could predict learning: greater brain coherence over right TPJ (high frequency 0.1-0.2 Hz) and right parietal region (low frequency, 0.03-0.1 Hz) was associated with better immediate learning. Importantly, we found that the student-teacher brain coherence and learning relationship was modulated by social cues: when teacher-student view was obstructed, better learning was predicted by greater coherence over left DLPF and left vPM, while the opposite relationship (lower coherence over the same regions, greater learning) was found for face-to-face trials. Some further preliminary investigation of the data hints at the possibility that greater joint attention in the obstructed-view condition led to greater coherence and greater learning, as compared to the face-to-face condition, where mutual gaze may have engaged mechanisms of complex social interaction, increasing brain coherence but possibly distracting from the learning task itself. Overall, we argue that being part of social interaction catalyses learning, possibly via mechanisms of joint attention and mutual predictions, which in turn are reflected in brain dynamics of interacting minds.

Artificial partners to understand joint coordination

I

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When studying joint action, it is difficult to disentangle the individual contributions and the way each participant reacts to partner actions. A way to overcome this problem is to design experiments where human participants interact with simulated artificial partners (AP), whose traits and interaction strategies can be manipulated. These approaches, referred to as virtual partner interaction or human dynamic clamp, provided important contributions to the study of dynamic coupling in continuous joint action. However, they did not explicitly model crucial determinants of sensorimotor interaction, like perception, decision-making and control mechanisms, which limited their potential to unveil the sensorimotor mechanisms underlying joint coordination.

Here we present a biomimetic AP architecture which builds upon a computational model of joint action. We assess AP performance in an interaction paradigm where two agents perform reaching movements between the same start and target, crossing different via-points while mechanically coupled (two-VP task). We show that humans interacting with either the artificial partner or another human exhibit similar behaviors. These findings suggest that interaction with an artificial partner is a viable method to study the mechanisms underlying the development of joint coordination. Further, biomimetic artificial partners may suggest new ways to facilitate skill learning and neuromotor recovery.

Partner representation and decision-making in joint action

P1

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More reliable information about the partner leads to faster development of joint coordination. This may not be the case when there are multiple cost-equivalent action options. Two agents walking in a narrow alley in opposite directions must decide which side to keep when they meet. Even if they see each other, they may remain stuck by cycling left and right.

To study how we deal with these situations, we developed a variant of a previously reported 2-via-points task. Two physically coupled agents move from the same start and end point, through different via-points. Via-points were placed symmetrically to the start-end line, so that the task had two cost-equivalent Nash equilibria (players crossing both via-points together). In two dyad groups, we varied the information available about the partner.

Overall, dyads get closer to one of the Nash equilibria. However, irrespective of information reliability, only a fraction achieved a stable coordination. We analyzed the experimental data with a computational model which relies on Bayesian principles for optimal prediction of partner actions and game theory for decision making and action selection. The estimated model parameters suggested that stable coordination requires a combination of reliability of partner representation and initial exploration in action selection.

Language differences do not prevent Joint Memory Representations

P2

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Presence of other people has been shown to affect how we process and memorize information in our environment. When performing tasks together, people represent not only their own task but also their partner's. There is evidence that, when presented with categorical words, people spontaneously encode words from their partner's category (Joint Memory Effect). The current research aims to investigate whether giving instructions in a common language is a precondition for encoding partner-relevant items. Literature on group membership would predict that partners speaking different languages will not represent each other's tasks as task partners speaking the same language, as the other is considered an out-group member. Therefore, we expected reduced memorization for partner-related items. In our study, each partner had to respond to one of the three picture categories (animal/plant/object) leaving one unassigned, extending the prior paradigm to pictures. Preliminary results show that task partners memorize the pictures relevant for their partner's task, therefore replicating the Joint Memory Effect. Additionally, we show that having instructions in different languages does not diminish the Joint Memory Effect. We conclude that people represent their partner's task even when their partner is instructed in an incomprehensible language, as they are aware of their partner's intentions.

Linking communicative modulations to distal goals: motor-iconicity or arbitrary mappings? P2

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The successful unfolding of many social interactions relies on our capacity to predict other people's action goals, whether these are proximal (i.e., immediate) or distal (i.e., future). The present set of studies asks whether observers can predict the distal goal of two-step action sequences when presented with communicative modulations of the first movement component within the sequence. We conducted three online experiments in which we presented participants with animations of a box moving in two steps towards one of two occluded target locations. On the basis of kinematic modulations of the first movement only, participants selected the most likely target location of the box. In Experiment 1 we found that participants require velocity information contained in the first movement in order to simulate a distal goal. The results of Experiment 2 indicate that such simulations are possible even in the absence of a second movement. Finally, in Experiment 3, we found that under some circumstances the second movement in the sequence can play an important role in how observers simulate a distal goal. We discuss these results in terms of the underlying simulation processes that enable observers to predict a distal goal from the observation of proximal communicative modulations.

Saying things with actions — or how instrumental actions can take on a communicative function

E

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Several attempts have been made recently to define what distinguishes communicative movements (e.g., gestures, demonstrations) from purely instrumental, goal-directed ones. The purpose of this talk is to contribute to such attempts in two ways. First, we propose a set of dimensions along which instrumental and communicative movements differ, according to a) their kinematic features, b) their co-production with other bodily signals, and c) the larger activity within which the movements are embedded. We argue that variations along any of these dimensions can account for one of the most distinguishing, yet puzzling features of communicative movements: their representational status. Second, we draw on recent work on sensorimotor communication and suggest that this form of communication, given its reliance on both instrumental and communicative goals, offers a unique standpoint from which researchers can start addressing questions relating to how movements gradually acquire their representational status, and how this new status can be actively exploited for the purposes of communication and joint action.

Behavioral and EEG Evidence For Attentional Capture By A Partner's Target D

Dominik Dötsch and Anna Schubö

Philipps University Marburg

In two studies, we investigated whether assigning social value to a salient yet irrelevant object modulates the extent to which the object captures attention in a joint variant of the additional singleton task.

In the first study (Dötsch et al., 2022), agents took longer to respond to own targets presented together with the partner's target compared to a neutral stimulus of equal salience. Agents also produced more false alarms in response to ambiguously colored stimuli similar to the partner's target color compared to stimuli similar to a neutral stimulus color.

In the second study (Abbasi et al., 2023), we recorded the agents' EEG activity during the task. Time-frequency analyses showed that the partner's target induced a negative parieto-occipital alpha-lateralization, indicating attentional capture, when the agent's own target was absent. Moreover, the alpha-lateralization index for partner targets was negative in a cooperative context, indicating attentional capture, whereas it was positive in a competitive context, indicating attentional suppression.

We suggest that attention is tuned to an object relevant to a partner during joint action. This is reflected in neural activity that differs from activity triggered by a neutral distractor, and is modulated dependent on the social context of the joint task.

Keywords: social value, attentional capture, selective attention; partner target representation, alpha-band power, social context

Role of the dopaminergic system in interpersonal performance monitoring: behavioral and EEG studies on Parkinson's Disease

K

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To successfully interact with others, the ability to flexibly monitor and adapt one's own motor performance to that of a partner is crucial. Neurodegenerative disorders such as Parkinson's disease (PD) can alter motor and cognitive abilities with possible negative effects on the capacity to interact with others. To address this issue, in a first study, we asked PD to synchronize their movements with those of a virtual partner in conditions that did (Interactive) or did not (Cued) require to predict and adapt to its actions. PD performed the task during daily antiparkinsonian treatment ('On') or after drug-withdrawal ('Off'). In the Interactive condition, PDs performed better when in 'On' than in 'Off' condition. This pattern of results hints at the key role of the dopaminergic system in supporting the flexible adaptation of one's own actions to the partner's during motor interactions. In a second, ongoing, study, PD patients performed the same task of the first study, while electroencephalography was recorded to investigate the neurophysiology underpinning altered performance monitoring. Results might inform the development of rehabilitation protocols combining non-invasive brain stimulation and interpersonal motor interactions to boost neurophysiological markers of performance monitoring and thus facilitating functional recovery in PD.

On the role of ancillary body movements in joint music making and interpersonal synchronization P2

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Joint music making (JMM) is a widespread human behavior. However, research in this domain typically involves expert musicians. In this project, we test whether spontaneously-generated (ancillary) body movements facilitate interpersonal synchronization during JMM, and whether this occurs irrespective of musical training. We are conducting an experiment in which dyads play songs using e-music boxes: a digital instrument that allows non-musically trained participants to control the tempo of preregistered songs by executing cyclic rotational movements. Each participant controls a different part of the music (either the melodic or the rhythmic part, comprising two different instruments each) while either seeing or not seeing the partner (but always without seeing their instrumental movements on the e-music boxes). We also instruct participants either to limit their ancillary movements, or to freely execute them. The participants' performances are encoded as continuous oscillatory data and are currently being analyzed using linear and nonlinear methods. Preliminary results suggest that interpersonal synchronization is enhanced when seeing the partner. Ongoing analyses aim at establishing whether this effect is mediated by ancillary movements. The results are expected to shed light on the universal capacity to use music and movement as a means of sensorimotor communication.

Acting jointly is not just acting side-by-side: K An EEG hyper-scanning study

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Anyone who has ever walked, cooked or crafted with a friend is in a position to know that acting jointly is not just acting side-by-side. Yet scientific studies on joint action routinely contrast joint with solo action—thereby failing to isolate what is distinctive, among social phenomena, of acting jointly. The present study aims to fill this gap. We used EEG hyper-scanning to investigate whether there are markers of action planning and execution specific to joint action. If so, they should be absent when agents plan and execute similar movements in parallel but merely individually. Twenty dyads had to move either one object (Joint-Action Condition) or two objects (Parallel-Action Condition) to a target using a joystick. The tasks were carefully constructed to equalize coordination demands across conditions. Measurements included two event-related potential (e.g. CNV and MRP)—as well as alpha-mu rhythm suppression in sensorimotor cortices during motor preparation and execution. We also conducted analyses of inter-brain synchrony. Data hint at enhanced CNV and MRP, and stronger alpha-mu suppression, in the Joint- compared to Parallel-Action Condition. Our data reveal markers of planning and execution that distinguish merely acting in parallel (even when this demands monitoring and coordinating) from genuinely joint action.

Chatting About Different Subtypes of Abstract Concepts Differently Modulates Closeness Among Interlocutors

P1

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Abstract concepts (i.e., “democracy”, “religion”) are intrinsically social in their origin and function, consequently, any verbal interactions with abstract contents might promote a sense of “psychological closeness”, since the actors draw from the same source of collective knowledge. In two studies we asked participants to converse through an online platform starting from abstract and concrete concepts (i.e., “table”, “cat”). After each conversation, the psychological distance and the physical/interpersonal distance between the actors were measured, respectively through the Self-Other inclusion test (iOS) (Aron et al., 1992) and a visual analogue scale (VAS) where the distance between two avatars embodying the interlocutors could be regulated. Crucially, participants were also asked to indicate in a visual analogue scale (VAS) the level of commitment, the perceived difficulty, the pleasantness, the intimacy, the self-contribution, and the other-contribution to the virtual conversation. The higher participants rated Self- and Other Contributions to the conversation, the more they felt psychologically and physically close to the interlocutor. This happened when conversing about abstract concepts, particularly philosophical-spiritual (e.g., “destiny”) and emotional concepts (e.g., “silence”), compared to concrete concepts (e.g., “airplane”). Results confirm views showing that social interaction is crucial for abstract concepts.

Neural evidence for anticipatory representations during Joint Actions

B

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Joint actions are defined as coordinated interactions of two or more agents, motivated by common goals. Growing evidence is showing that, during joint actions, incongruent movements of the partner cause less interference on our own movements, compared to a situation in which agents act alongside, but not cooperatively. It has been suggested that such a reduced visuomotor interference results from the proactive anticipation of the partner's movements, which become integrated into a joint action plan.

In this study, we collected EEG data while participants drew shapes simultaneously to a virtual partner, in two social contexts: either they had to synchronize and act jointly, or they performed the actions independently. We tested the extent to which the social context influenced visuomotor interference, quantified in the distortion in the drawn trajectories. At the neural level, we used multivariate analyses to investigate how strongly the partner's action was encoded during the preparatory interval preceding the movement. We found initial evidence that successful joint actions entail stronger anticipation of the partner's movement, indexed by higher classification accuracy, supporting the hypothesis that acting together leads to the formation of an action plan that accounts for the partner's movement.

Co-representation of an imagined partner's task; the effect of imagined joint action and facial trustworthiness

P2

Kassandra Friebe and Günther Knoblich

Central European University, Vienna

We often imagine ourselves acting together with others in order to mentally prepare for the course of a particular action. Although previous studies suggest functional equivalence (Jeannerod, 2004) and similar underlying patterns of neural activity (Decety, 1996) in covert and overt individual actions, imagined joint actions are still sparsely studied.

Studies on impression formation and co-representation suggests that partner-related information can be rapidly integrated and influence the extent to which a partner's task is co-represented in real-world joint actions. What remains to be understood is the level of detail at which we integrate information about the other into our own action system during imagined joint actions.

This study investigates the effect of imagined joint action and facial trustworthiness on co-representation of an imagined partner's task. An online adaptation of a joint Simon paradigm was used to examine the joint Simon effect and the influence of task partner valence in covert interactions. Participants ($N = 31$) performed a Go/No-Go task either individually or jointly with imagined partners represented by faces varying in facial trustworthiness. Results showed a significant two-way interaction of compatibility and type of task (joint vs. individual performance; $F = 4.739$, $p < .037$), indicating that the joint Simon effect replicates during imagined joint actions. However, facial trustworthiness did not influence the extent to which we co-represent an imagined partner's action, indicating that the extent to which partner-related information is integrated into the action plan might differ in covert and overt joint actions.

Overall, this study sheds light on the mechanisms underlying the co-representation during imagined joint actions and their sensitivity to social cues.

Joint language production and the representation of others' utterances: What next

J

Chiara Gambi¹ and Martin J. Pickering²

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In this talk, we survey a growing body of work which compares how speakers produce language in joint versus individual tasks to uncover when and how speakers engage in co-representation of others' utterances. This work shows that the process of producing language is susceptible to influence from representations of others' utterances (whether real or assumed). There is also good evidence that co-representation makes use of language production mechanisms, but typically stops short of engaging in deep, detailed simulation of what another person is saying. Crucially, we identify three topics for future research. (1) Which factors influence the flexible use of simulation-based mechanisms? How do the nature of the communicative context and the partner's identity affect the depth of co-representation? (2) Is co-representation cognitively demanding? And if so, is it only available when one is not speaking at the same time? Finally, the focus so far has been on the extent to which similar mechanisms are used for representing one's own and others' utterances, but future work should also (3) explore whether speaking jointly involves dedicated mechanisms (e.g., variability reduction) that are not relevant when speaking in isolation.

Affective observation: generalization of negative emotional expressions targeting action performances

P2

Thomas Ganzetti and Günther Knoblich

Central European University, Vienna

Recent research has highlighted the significance of emotional displays as tools for navigating complex environments and dealing with unfamiliar cultural content (Clément & Dukes, 2022). Specifically, affective observation refers to a process in which learners actively seek relevant information by observing emotional expressions displayed in third-party interactions.

The present study focuses on negative emotional reactions targeting action performances and investigates whether information retrieved during affective observation is perceived as being generalizable, that is, whether an observed negative reaction to an action is also expected to be displayed by novel individuals. We hypothesize that the expectation of a congruent emotional reaction is stronger when the target of the reaction is an unfamiliar action compared to a familiar one. In fact, prior knowledge can conflict with observed emotional information in the case of familiar actions, while in the absence of prior knowledge, emotional information is the only available tool to create anticipations of novel individuals' reactions and evaluations. In this within-subjects design, participants are presented with pictures of observers negatively reacting to individuals performing either familiar or unfamiliar instrumental actions. They are then shown the same action performed by a novel individual and asked to select which reaction they expect to be displayed by a novel observer (negative or neutral).

Pilot data (n=10) suggests that negative evaluations tend to be generalized more consistently when the target of the emotional display is an unfamiliar action than when it is a familiar one.

This study contributes to the understanding of humans' navigation of complex cultural environments by shedding light on the role of affective mechanisms in the generalization of social information.

The Role of Individual Considerations in Joint Decision-Making

P2

Tiam Ghorab, Luke McEllin and Natalie Sebanz

Department of Cognitive Science, Central European University, Vienna

Team decision-making can be challenging due to the possibility of conflicting opinions impeding the chances to reach a consensus. However, a body of literature shows that groups can outperform individuals in decision-making when they engage in joint deliberation. Similar results have been shown for bargaining tasks like the ultimatum game, where groups exhibit more rational behaviour than individuals. However, in such bargaining situations, what is the impact of individual considerations prior to joint deliberations for group performance? Previous research suggests that exchanging arguments may enhance decision accuracy in groups. Thus, we hypothesize that individual contemplation prior to joint deliberation predicts higher decision accuracy, as ready-made arguments can improve the efficacy of the decision aggregation process. To investigate this, we will employ a sequential ultimatum game involving two participants forming a team as recipients against a single proposer. The team communicates via a chat room while sitting in separate rooms to jointly deliberate to reach a unanimous decision. Participants will be placed in one of two conditions: either an individual deliberation condition in which they announce their individual decision first before jointly deliberating or a joint deliberation condition where they discuss immediately without individual contemplation.

Follow My Lead! Followers' Reliability Modulates Leader's Goal Persistence in a Novel Joint Goal-Setting Paradigm

P1

Felix J. Götz and Gesine Dreisbach

University of Regensburg

Goal-directed behavior requires an adaptive balance between goal persistence vs. disengagement. However, little is known about setups that involve more than one (co-)actor. Here, we introduce a novel joint goal-setting paradigm to investigate effects of co-actors' reliability on an individual's goal persistence. A participant and a confederate were asked to move a target from the bottom center to the top left or right corner of the computer screen in two steps. In the first step, the participant visibly indicates his or her corner of choice. In the second step, the confederate then moves the target to its final position. Critically, the confederate followed the participant's lead in 80% (reliable follower) or 50% (unreliable follower) of the trials. Follower reliability was manipulated between (Experiment 1) or within participants (Experiment 2 and 3). In Experiment 3, the confederate changed between reliability conditions in addition. Results show that participants repeated their corner choice when the confederate had not followed their lead in the previous trial, but only when they had experienced the specific confederate as reliable (Experiment 1 and 3). These findings show that goal persistence in joint action depends on the reliability of the co-actor.

Follow Me - follow You? Interacting with a Human But Not a Computer Motivates Conflict Adaptation in Interindividual Response Conflict

P2

Felix J. Götz and Gesine Dreisbach

University of Regensburg

Response conflicts and their sequential adaptations are typically investigated for conflicts between an instructed and a competing automatic response tendency, triggered by different stimulus features. In the present study, comprising six Experiments, we investigate conflicts between a participant's and a co-actor's competing response goals and their sequential adaptations in a novel paradigm. Specifically, the participant and a co-actor (another human or the computer) move a target relay-like in two steps from the bottom center to the top left or right corner of the computer-screen. In a first block, participants must always follow the co-actor's goal choice (follower training; Experiments 1, 2). In the critical second block, participants are free to follow either's goal choice. Experiments 3-6 explored modifications of the basic paradigm (order of blocks; leader training; humanized computer co-actor). In all six Experiments, participants showed congruency effects whereas conflict adaptation effects were almost exclusively found for second blocks (mostly free-choice) and only if participants cooperated with a real or imagined human co-actor. Thus, the 'relay paradigm' allows to examine interindividual response conflicts between co-actors in different roles (follower, leader, decider) and settings (lab or online) and offers new insights into the functionality of conflict adaption.

Stable asynchrony? Associations between borderline personality traits and interpersonal asynchrony

P1

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Interpersonal synchrony is a relational phenomenon linked to prosocial behavior and affiliation. It requires interpersonal coordination and well-defined interactive flexibility to emerge. While research has investigated the underlying cognitive and social mechanisms that facilitate interpersonal synchrony, much less is known about how it is influenced by relational difficulties in various psychopathological conditions - such as Borderline Personality Disorder (BPD), which is characterized by interpersonal dysfunction. In this study, we investigate the influence of BPD traits on interpersonal synchrony. Participants (N = 206) were recruited from the general population. BPD traits were assessed, and interpersonal synchronization ability was measured with a finger-tapping task. Participants were instructed to interact with a virtual partner (VP) that varied its cooperation level in response to their taps in different conditions of adaptivity (α). After each interaction, the subjective experience was assessed. Results showed a main significant effect of the adaptivity of the VP on interpersonal synchronization and on the experience of the interaction. BPD traits were associated with asynchrony, instability, and a negative experience of the interaction. These findings show that BPD traits are associated with impaired interpersonal synchrony so clinical implications are outlined.

Joint history of play provides means for coordination

P1

Christophe Heintz² and Liubov Voronina¹

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In this study we investigate how joint history shapes strategic decisions for the equilibrium choice in pure coordination games. In the games, which histories did not suggest a choice of any specific colour, we observed a significant improvement of coordination in the last round. Interestingly, the coordination index for this round did not significantly change between the conditions with and without joint history. Therefore the actual coordination rate exceeds the rate of the expected coordination, when the choices are made by the randomly paired participants. In the games, where a history of rounds nudged the choice of a given colour, we observed that this same colour tended to be chosen in the last round. This is how precedence determines coordination strategy. More precisely, people accurately predict that a winning strategy used in the past is mutually salient and can be successfully used again in similar situations. We demonstrate that precedence is strongly relied upon and provides insights into the psychological bases of social processes through which conventions emerge. By investigating path dependence of the individual behaviour in the context of coordination, we experimentally confirm that conventions emerge because people systematically rely on their past interactions in order to coordinate successfully.

Smoothing coordination: the Ladyginian way and the Gricean way

E

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Coordination is smoothed when coordinating agents can accurately predict each others' actions. To achieve this goal, coordinating agents might want to inform their partner about their intentions. We distinguish two different ways by which agents can do this, and we argue that humans slide effortlessly between these two different ways in everyday life. Consider two people, Jane and Paul, walking towards one another on a relatively narrow street. Jane might move towards the right, in advance of their passing, with the intention to give Paul evidence that she intends to pass on the right. We call such behaviour 'Ladyginian'. Jane might however not simply move towards the right, but actively exaggerate her movement so that Paul sees and identifies the exaggeration itself as an effort to inform him. We call such behaviour 'Gricean'. In this Gricean case, and not the Ladyginian case, Jane reveals not simply her intention to pass on the right, but her specifically informative intention that Paul believes she intends to pass on the right. Many findings in the study of joint action reveal how humans make their informative intentions manifest just to the extent necessary for their informative intention to be satisfied, but no more so.

Multimodal addressee responses as tools for coordination and adaptation in conversational interaction

J

Judith Holler

Donders Institute for Brain, Cognition & Behaviour, Radboud University
Max Planck Institute for Psycholinguistics

Traditionally, in much of the language sciences, the focus has been on the individual speaker speaking in isolation. Addressees are typically seen as passive recipients, and frequently do not feature in experimental paradigms at all. In this talk, I will illustrate that addressees in face-to-face interaction are extremely active collaborators, as evidenced by analyses of their vocal and visual contributions, including co-speech manual gestures, facial signals and head gestures, based on both conversational corpora and experiments. Further, I will throw light on the temporal organisation of multimodal conversational contributions by demonstrating that addressees' visual signals often occur in parallel with on-going speaking turns, and thus outside of the typical feedback 'slots'. As such, they pose a challenge in terms of conceptualizing language production and comprehension in dialogue and should be integrated in models of conversational turn-taking. While this has been the *modus operandi* for many decades in some fields of enquiry (such as conversation analysis), it still needs to find proper recognition in many other branches of the language as well as the cognitive sciences. The findings I present are a call for pushing to move more strongly into this direction and propose a framework for doing so.

Birds of a feather excel together? The impact of dyadic motive fit on performance in a joint action task

P2

Hüttner, N., Müller, F. and Cañal-Bruland, R.

Friedrich-Schiller-Universität Jena

In many daily situations, two or more individuals have to coordinate their actions to achieve a common goal and perform successfully. Past research on joint action has predominantly focused on the question of how such interactions are accomplished (e.g., Sebanz et al., 2006). In a recent study (Hüttner et al., 2023) we focused on the impact of inter-individual trait differences to predict joint action performance. More specifically, we explored whether performance and communication in a joint action task is moderated by the (in)congruence of individuals' motive dispositions. To this end, 27 dyads performed a Tilting Labyrinth Task (TLT) in which they had to navigate a ball through a maze with each partner using a joystick and each being responsible for either moving the ball along the x-axis or the y-axis. We analyzed dyads' performance (times and errors) and communication (speaking time). Implicit and explicit motives by means of the Picture Story Exercise and the Unified Motive Scale, respectively, served as trait-like predictors. Linear regression modeling revealed that congruent explicit affiliation motives predict faster best times and that higher congruent implicit achievement motives are associated with reduced errors. Exploratory Response Surface Analyses yielded identical results for the affiliation motive. These findings provide initial evidence to suggest that interindividual differences in motives as well as their fit are related to joint action performance and communication. Future directions of this new paradigm and novel ways to analyze dyadic motive fits and their relation to joint action performance are discussed.

Haptic Turing test and learning with robotic and human partners

I

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To move a table or dance together, people do not need to communicate verbally, instead they understand how to move with the partner(s) through exchanging force and touch information. We have shown previously that such haptic communication can improve the performance of each team member, so that even the best can benefit from the interaction with less-skilled. We have further deciphered the mechanism of haptic communication by creating a reactive controller that induces interaction benefits similar to those of a human partner. We recently tested the effect of the interaction with this robotic partner on performance and learning, and whether humans can differentiate it from a human partner. The interaction with the robot and human partners was not perceived differently; i.e. our robotic partner passed haptic Turing test, though some of the attributes were different with the robot. Moreover, training with robotic and human partners showed similar learning effect, resulting in slightly superior performance over solo training. In contrast, the interaction with haptic guidance typical of current physical training robots modified and deteriorated the tracking behaviour. Overall, these results suggest that haptic interaction is crucial for joint physical actions and can be used to design intuitive robots for physical interaction.

Examining the association between synchronization and social cohesion through the lens of creativity. An empirical study

P2

Adrian Kempf

University of Graz, Ghent University, University of York

Music-induced synchronization is associated with increased social cohesion to virtual co-actors. The present work aims at deepening our understanding of this relationship by exploring how different individual cognitive factors may shape it. In particular, we focused on factors connected to creativity (e.g., divergent thinking ability, openness to experience) as they are known to play a key role in musical group performance.

49 participants engaged with a 3D-avatar playing a drum beat within a mixed-reality. After completing background questionnaires on creativity and musical training they participated in three conditions: “Watch” (participants watched the avatar play); “Follow” (participants synchronized with the avatar); “Lead” (similar to “Follow” but involved an adaptive avatar based on a Kuramoto algorithm). After each condition, the participants’ feeling of social cohesion, conceptualized as self-other integration, was assessed via IOS scale and joint-Simon task. The participants’ divergent and convergent thinking abilities were also assessed.

Final results of this pre-registered study will be available by the time of the conference. We predict that the association between synchronization and social cohesion is moderated by divergent thinking ability, as it increases flexibility in self-other integration. If corroborated, this result may improve our understanding of the relationship between social cohesion, synchronization, and creativity.

Influence of expectations of co-efficiency on action prediction

P2

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In joint tasks, people tend to act co-efficiently (Török et al., 2019). Another line of research shows that expectations of individual efficiency bias perceptual estimates towards least-effortful trajectories (Hudson et al., 2018). We investigated whether people have expectations of co-efficiency and if those expectations inform action prediction when observing an interaction between two agents. In Experiment 1, participants viewed a recording of a virtual game involving two players. The bottom agent would lead a ball half-way across the screen where the top agent would take over and lead it to the end position on the top of the screen. Layouts of obstacles on the screen were varied so that the bottom agent could choose individually or jointly efficient paths. In most trials, the ball disappeared during transit, and participants had to click at the ball's last location. The dependent measure was the spatial difference between the actual and reported last location of the ball. Results showed a bias towards paths that are efficient only for the bottom agent. In subsequent experiments we are modifying the procedure so that the task requires attending to the bottom and top agent's obstacles equally. Data collection is expected to be completed in April 2023.

Rigorous action synchrony compromised in a virtual space without the risk of physical body collision

P1

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The risk of the physical crash of a body causes the emergence of a strict spatial-temporal pattern of joint action. We tested this hypothesis using a virtual reality space. Groups of three students were asked to perform a triadic jumping task in a symmetrical and asymmetrical task space in the real world. Temporally rigorous synchrony with a lag on the order of tens of milliseconds and the robust effect of the task space symmetry on the spatial order of the jumper's synchrony were reproduced as confirmed in a previous study (Kijima, et al., 2017). Subsequently, the groups were asked to perform the triadic jumping task in an immersive virtual task space. The effect of the task space symmetry was maintained. However, the lag and variability among the three jumpers' timing of jumping action significantly increased. Thus, the temporally rigorous synchronisation was compromised by eliminating the risk of the physical crash of the jumpers' bodies. Further, we tested the effect of the physical risk of the crash in the virtual space by implementing the impact of a collision using vibration stimuli. However, the synchrony was still compromised. The constraints necessary for physical rigour synchrony will be discussed based on the result.

Postnatal dependency and its contribution to joint action understanding P2

Christian Kliesch

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Engaging in joint actions requires both partners to predict and engage with each other in order to plan and coordinate with each other. In this paper, I want to take an ecological and enactivist perspective on early development and argue that the ability to represent others and engage in joint actions emerges from human infants' prolonged period of postnatal care that limits infants' engagement with the world. Instead, they act on the world through their caregivers, and subsequently predict the actions of others. Human infants are born particularly premature compared to other species, even amongst higher apes (Piantadosi & Kidd, 2016). Whereas offspring of other species, including other apes, becomes mobile relatively early, human infants spend a particularly long period of their life with highly restricted mobility and dependent on their caregivers (Piantadosi & Kidd, 2016). Their experience and ability to act on the world becomes moderated through others and subsequently, they will learn to predict others in just the same way that they learn to predict their own actions, or later in life, tools (Gibson, 1986). It is this particular environment that provides the foundations of human communication (Pickering & Garrod, 2004, 2014), imitation (Heyes, 2005, 2021; Jones, 2009), social learning (Heyes, 2018) and joint action (Sebanz, Bekkering, & Knoblich, 2006; Sebanz & Knoblich, 2009).

Real and perceived human agency affect interpersonal synchrony: A mental coordination task

I

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Attribution of human agency has been shown to promote social alignment. The latter has been positively linked with temporal interpersonal synchrony. Despite their positive relation with social alignment, little is known as to how attribution of human agency and interpersonal synchrony relate to each other. To this end, we employed a mental coordination task where dyads of participants were asked to synchronize with their partners by counting internally to presented numbers. In some blocks, participants played with the human partner (human condition) and in others, they played with the computer (computer condition). Importantly, we also collected participants' responses related to the perceived nature of the partner. Results showed that participants achieved a higher interpersonal synchrony with the human compared to the computer partner. However, when participants attributed human agency to their partner, they synchronized less compared to when they perceived the partner as a machine, but only in computer condition. Finally, related to participants' accuracy about attribution of human agency, our results indicated a higher sensitivity in perceiving the human nature of the partner. Overall, our study suggests that both the real and the perceived nature of the partner can affect interpersonal synchrony, even in the absence of continuous feedback.

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Interpersonal synchrony across bodily and neural signals has been a prominent focus within joint action research. However, the dynamic mechanisms that underlie self-other integration and segregation during interpersonal synchronization remain poorly understood, and particularly the consequences that interpersonal coupling may have on the self, or intra-personal coupling. Previous research suggests that interpersonal synchrony impedes self-regulation[1], and previous computational work suggests that people's theoretical self action-perception loops become decoupled when they adapt to another person during interpersonal coordination[2]. Here, I present empirical evidence of self-decoupling of bodily and neural rhythms, and an overly-coupled self as a result of audience effects. In study 1, people's intrapersonal cardiorespiratory rhythms became decoupled when they synchronized their breathing to another person's (in contrast to a baseline), and this decoupling was stronger in the bidirectional synchronization condition than the unidirectional one. In study 2, people had reduced functional connectivity when they synchronized their movements with another person, compared to when they produced independent movements[3]. Interestingly, when their actions were observed, but not followed, they had increased functional connectivity, presumably modulated by audience effects. This work suggests that synchronizing with others is facilitated through self-decoupling mechanisms, which may be a dynamic mechanism for self-other merging versus segregation.

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Origins of interpersonal neural synchrony in spontaneous dyadic behavior

G

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Synchronization of neural activity across brains - interpersonal neural synchrony (INS) - is emerging as a powerful marker of social interaction that predicts success of multi-person coordination, communication, and cooperation. As the origins of INS are poorly understood, we tested whether and how INS might emerge from spontaneous dyadic behavior. We recorded behavior and neural activity (EEG) while dyads of participants were instructed to simply look at each other without speaking or making co-verbal gestures. We made four fundamental observations. First, despite the absence of a structured social task, INS emerged spontaneously. Second, such spontaneous INS reflected dyad-specific coupling of neural activities. Third, using state-of-art video-image processing and deep learning, we extracted the temporal unfolding of three notable social behavioral cues - body movement, eye contact, and smiling - and demonstrated that these behaviors also spontaneously synchronized within dyads. Fourth, we probed the origins of INS in such synchronized social behaviors. Using cross-correlation and Granger causality analyses, we show that synchronized social behaviors anticipate and in fact Granger cause INS. Together, these results provide compelling evidence that INS is an emergent property of two coupled neural systems: an entrainment phenomenon, promoted by real-time dyadic behavior that can be studied under natural and unconstrained conditions.

With or without you: An EEG study on interpersonal coordination

K

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Successful interpersonal coordination often benefits from an action plan, which includes the representation of the actions of all people, who are involved in the interaction. In the present study, we investigated whether representation of a co-actor's actions during joint action planning depends on the coordination demands of a joint task. EEG was recorded from 26 neurotypical participants, during a cue-response joint action task, in which visual cues were projected on a table, and indicated the type of the action to be performed. The participants' task was to raise a glass either individually or jointly with another person in a synchronous or in a sequential manner. Rather unexpectedly, there was no difference in EEG activity between individual and synchronous raising of glasses, indicating that in the latter condition the participants were focusing only on their own part of the task. A more nuanced picture was revealed in sequential raising of glasses; the most interesting finding was that the amplitude of movement-related potentials was larger before sequential action onset, suggesting the existence of a more complex action plan. Our findings suggest that a threshold of difficulty must be breached for the representation of another person's action to occur during joint action planning.

Partner-elicited semantic context effects: elusive and (potentially) insightful

J

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Social interactions often involve speaking. As for other types of joint action, it has been proposed that interlocutors coordinate in time, and in content, by co-representing their partner's actions. This has consequences for own speech production. This talk gives an overview over a series of studies investigating the ease with which speakers gain lexical access in joint action settings. For this we scaled up classic speech production paradigms, designed to investigate interference from semantically related context words, to social settings in which two speakers take turns speaking. One strength of these paradigms is that they allow insights into the nature of the partner representation. Our data indicate that (1) in some settings the partner's action is simulated, to the level of seeking lexical access on behalf of the partner, eliciting semantic interference during own speech production, (2) in other settings the partner does not seem represented at all, and (3) in yet other settings the partner's actions may be represented on the conceptual level, shifting semantic interference towards facilitation. Based on published and unpublished data I will speculate about the currently unresolved question which factors may influence whether and how a partner's action is represented in spoken interaction.

Agency and social affordance shape visual perception

P2

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The sense of agency raises growing interest in the field of joint action. It has been shown to modify the way we estimate the timing and the intensity of action-effects, but little is known regarding its influence on visual perception. The present study used the Representational Momentum paradigm to measure participants' visual anticipation of another agent's movement. . We conducted two experiments in which a virtual human performed a handshake gesture aimed at a second virtual human. We manipulated agency in the first experiment by comparing a condition where participants triggered the virtual agent's gesture with a condition where the computer triggered it. When participants triggered the gesture, they showed greater forward movement anticipation. The second experiment investigated how altering social affordance by changing interindividual distance, and body posture modulated the relationship between agency and visual anticipation. Contrasting with the first experiment, participants anticipated a backward movement of the hand when the computer triggered the gesture and displayed a null anticipation when participants triggered the gesture. The outcomes of this study showed that agency and social affordance interact to shape perception and entail a rethinking of the models of agency processing.

Are you sure it's your voice? Exploring the relations between phonetic alignment and sense of agency

P1

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When speakers interact, their behavior tends to converge as they try to anticipate each other's actions. Speakers also predict the outcomes of their own behaviors. However, studies on auditory feedback (i.e., self-generated voice) during speech production show that mismatches between the sensory signal and expected outcomes of speech motor commands trigger a compensatory response, rather than a converging response. These observations imply that speakers adjust their production based on their sense of agency of the input signal. In this study, we investigated whether a constant mismatch between the perceived and expected pitch of a speaker's voice could alter their sense of agency on their self-generated voice. In an experiment, participants were asked to read sentences with a delayed self-generated voice while part of the participants' voice was shifted higher or lower. The results show that most participants whose voice was shifted aligned their pitch to their pitch-shifted voice and lengthened their accented vowels less in response to the delay than the participants whose voice was not shifted. These findings suggest that pitch alignment to unexpected self-generated signals indicates a reduction of speakers' sense of agency on their voice, making them less perturbed by the delay of their auditory feedback.

Tempo Change and Leadership in Ensemble Synchronisation: A Case Study

P2

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The ability to synchronise is a hallmark of professional music-making. Such synchronisation, without a conductor, is achievable by timing error correction, either through phase correction (Wing et al., 2014) or period correction (by adjusting the timekeeper interval; Schulze et al., 2005). Here we investigate how an ensemble employs such inter-personal adjustment of micro-scale timings to maintain synchronisation even whilst applying tempo changes associated with expressive musical interpretation. We invited the Coull Quartet to perform a Haydn excerpt in three different ways: 1) minimal temporal expression ('deadpan'), 2) 'normal' expression, 3) accelerando followed by rallentando. Leadership was assigned either to the first or second violin. Using linear and bounded generalised least squares (Jacoby et al., 2015) models of sensorimotor synchronisation, we estimated correction gain parameters for phase and period correction. Results suggested that the Coull Quartet tended towards a more democratic rather than hierarchical approach to group synchronisation. Interestingly, period correction was evident only when tempo changes were introduced into the performance, whereas phase correction was employed throughout, even during the 'deadpan' trials. These findings will help to develop interactive training tools for student chamber musicians.

Exploring Interbrain Synchronization using Two-brain EEG Microstates

G

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Joint action and coordination between individuals are integral parts of daily life, and various behavioral tasks have been designed to study their emergence and maintenance. One example is the mirror-game paradigm, which examines the dynamics of two people improvising motion together. However, the underlying neural mechanisms remain poorly understood, and interbrain methods underdeveloped. Previously, we reported unique individual behavioral and neural signatures of performing actions when observed by others using a mirror-game paradigm. Here, we explored interbrain synchronization during the mirror-game paradigm using a novel approach employing two-brain EEG microstates. Microstates are quasi-stable configurations of brain activity that have been reliably replicated across studies, and proposed to be basic building blocks for mental processing. Expanding the microstate methodology to dyads of interacting participants (two-brain microstates) enables us to investigate quasi-stable moments of interbrain synchronous activity. Interestingly, we found that conventional microstates fitted to individuals were not related to the different task conditions; however, the dynamics of the two-brain microstates were changed for the observed actor-observer condition, compared to all other conditions where participants had more symmetric task demands (rest, individual, joint). These results suggest that two-brain microstates might serve as a method for identifying interbrain states during real-time social interaction.

Modulation of broadband EEG on communication dynamics

P1

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Human communication has been formulated as an information compression problem: interlocutors produce and comprehend communicative signals with forward and inverse models of the form-meaning association. However, a fundamental question is how interlocutors communicate when form and meaning are not given in the first place. In this study, we investigate the behavioral and neural dynamics of how interlocutors co-construct a communicative system from scratch, by using the Embodied Communication Game (ECG) paradigm. In the experiment, two participants were randomly paired and sat in separate rooms, while their electroencephalograms (EEG) were simultaneously recorded. The pairs of participants controlled the movement of an icon on a screen with the goal of coordinating their choices when shared form and meaning was lacking. The movements were visible to both participants, and feedback was provided at the end of each trial. Their task was thus to establish a shared form-meaning system using only their movements of the screen icon. We found that both the communication outcome and dynamics varied across the interacting pairs. Each pair converged on different form-meaning signaling systems, and showed unique temporal signatures of communication. Moreover, preliminary results suggest that broadband EEG activity may track the pair-specific communication dynamics, independent from the occurrence of specific movements. These results suggest that emergence of a shared signaling system requires interlocutors to mutual infer and co-construct each other's behavior, and that this process may be associated with a fundamental change of the generative models of the interlocutors than specific sensorimotor output per se.

The sense of joint agency in joint music performance: A mixed-methods approach

F

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Joint action poses unique challenges for understanding people's sense of agency, that is, their sense of generating and controlling actions and their effects on the world. Namely, people engaged in a joint action can have a sense of agency not only at the individual level (a sense that "I did that" or "You did that"), but also at the collective level (a sense that "We did that together," referred to as joint agency). In this presentation, I will discuss a series of studies that investigated joint agency in musical joint action. These studies employed a mixed-methods approach that included experimental manipulations of joint agency in duet music performance and qualitative investigations of people's first-hand reports of joint agency in a variety of musical settings. Implications of our findings for understanding different forms of joint agency, including shared agency (a sense that agency is distributed among co-performers) and united or we-agency (a sense that co-performers are acting a single unit), as well as implications for models of agency in joint action, will be discussed.

The Importance of Action Observation in Perspective Taking

P2

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Because of our ability to take others' visuospatial perspective, we can imagine and estimate how one or another object looks to another person, where it is situated in relation to them, and whether and how they are able to act on it. Furthermore, when seeing another person acting, the activation of the corresponding action representations in our own motor system allows us to understand these actions and predict how they will unfold. Both of these capacities, perspective taking and action observation, form the basis for collaborative actions. Our experimental work investigated how these two fundamental abilities interact: whether seeing another person acting facilitates perspective taking and what are the mechanisms whereby this facilitation occurs. We conducted 4 experiments that included either manual or verbal responses from participants. Participants saw pictures of a model sitting at a round table at various angles either acting on one of the objects on the table or sitting still with one hand placed towards an object. Participants were asked to indicate if one of the objects was on the left or the right side of the model. The results showed that seeing the model acting increased the speed and accuracy with which participants took the perspective. Importantly, this effect was independent of the mental own-body transformation that is involved in perspective taking. The results also indicated that the representation of a specific effector that the action is executed by is driving these facilitation effects. We will discuss different mechanisms whereby observed actions modulate perspective taking.

Developing a new computational framework for quantitative analysis of motor styles P1

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A growing amount of both experimental and theoretical research suggests the existence of what could be defined as “motor style”. However, the operationalization of this construct into a computational framework is still poorly explored, limiting further investigation. We therefore developed an innovative approach based on the Procrustes Transformation. The dataset consisted of 16 sessions in which participants had to grasp and move an object while the same was done by a confederate, who remained the same for all sessions. The kinematics of the right upper-limb was recorded for both agents. Then the Procrustes Transformation was used to compare the obtained profiles of wrist velocity, acceleration and jerk. Finally, the Procrustes Distance (PD) (in the range 0-1) was computed between each of the possible 512 confederate-confederate or confederate-participant couples. The obtained PD was smaller for confederate-confederate couples (0.01-0.21; mean 0.09) than for confederate-participant ones (0.08-0.69; mean 0.37), showing that this new computational approach was capable of capturing the intrinsic regularity of the series of movements performed by the confederate during the 16 experimental sessions. Notably, this remained unaffected by the type of grip used. Therefore, we propose a promising approach to conduct quantitative research on motor styles and joint actions.

I move like you, I better read you: the role of 'motor distance' in action understanding

P1

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Research on movement kinematics has demonstrated that observers can predict the weight of a target object through the observation of the reach-to-grasp phase of a movement towards it (Podda et al., 2017). However, it remains unclear the extent to which the motor similarity between the observer's and agent's kinematics affects this accuracy. To address this, we combined motion capture technology with video recording to collect data from 34 participants performing grasping movements towards light and heavy objects. We used Procrustes transformation (Bookstein, 1992) to determine the motor distance between participants, and in a subsequent action observation experiment we tested the hypothesis of motor similarity. We presented observers - who had previously performed the action execution task - with a set of videoclips by manipulating the similarity (low, intermediate, high) between their kinematics and that presented in the videos. Observers were asked to watch the reach-to-grasp phase of the action and classify the target objects as heavy or light. Preliminary results suggest that higher observer/agent motor similarity leads to better classification performance. With data acquisition still ongoing, we expect results to reveal whether the ability to predict the outcome of observed actions depends on the 'motor distance' between observer and agents.

Associative Learning of Joint Action Representations

B

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To produce goal-directed behaviour, people need access to representations that encode instrumental relationships between their actions and resulting outcomes. Here we asked how co-actors acquire such representations in joint action contexts in which they purposefully coordinate their actions with each other to produce common outcomes in the environment. Using an action-effect learning task we assessed how associative learning of action-outcome relationships underlies the acquisition of action representations in joint action contexts. Pairs of participants performed an initial learning phase in which they produced a series of high and low two-tone chords by synchronizing individual button presses on separate but horizontally aligned response boxes. Subsequently, pairs performed a test phase in which they responded to the formerly produced chords with respect to a prescribed stimulus-response rule. Our results showed that participants' performance in the test phase was reliably affected by the compatibility of the prescribed stimulus-response rule relative to pairs' joint action-outcome mappings in the preceding learning phase. These results indicate that in joint action, associative learning of action-outcome relationships is sensitive to relational aspects between co-actors' individual action contributions towards common outcomes and can lead to the implicit acquisition of hierarchical joint action representations.

Investigating inter-brain synchrony during (un-)successful face-to-face communication

P2

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Human communication requires interlocutors to mutually understand each other. Previous research has suggested inter-brain synchrony as an important feature of social interaction, since it has been observed during joint attention, speech interactions and cooperative tasks. Nonetheless, it is still unknown whether inter-brain synchrony is actually related to successful face-to-face communication. Here, we use dual-EEG to study if inter-brain synchrony is modulated during episodes of successful and unsuccessful communication in clear and noisy communication settings. Dyads performed a tangram-based referential communication task with and without background noise, while both their EEG and audiovisual behavior was recorded. Other-initiated repairs were annotated in the audiovisual data and were used as indexes of unsuccessful and successful communication. More specifically, we compared inter-brain synchrony during episodes of miscommunication (repair initiations) and episodes of mutual understanding (repair solutions and acceptance phases) in the clear and the noise condition. We expect that when communication is successful, inter-brain synchrony will be stronger than when communication is unsuccessful, and we expect that these patterns will be most pronounced in the noise condition. Results are currently being analyzed and will be presented and discussed with respect to the cross-brain neural dynamics underlying the process of mutual understanding in face-to-face conversation.

Actions in economic games that contain cues to social preferences influence partner choice H

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Prudently choosing who to interact with and who to avoid is an important ability to ensure that we benefit from a cooperative interaction. While the role of others' preferences, attributes, and values in partner choice have been established, much less is known about whether the manner in which a potential partner plans and implements a decision provides helpful cues for partner choice. We used a partner choice paradigm in which participants chose who to partner with in economic games (either prisoners' dilemma or stag-hunt). Before making their choice between two partners, participants were presented with information about the potential partners' decision-related actions in another round of that same game. They received either information about the potential partners' planning during decision making or action execution during decision implementation. Across both games, participants preferred to interact with those whose action planning or action execution indicated they were making and implementing prosocial decisions (i.e., cooperate or stag) with certainty rather than uncertainty. This demonstrates that action cues present in either the planning or implementation of economic decisions influence partner choice, by revealing the strength of the social preferences of potential partners.

The Sense of Commitment in Joint Action: A Cross-Cultural Study

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Previous research involving American and Western European participants provides evidence that, in the context of joint action, individuals' sense of commitment sustains their motivation to persist in performing actions which their joint action partners are expecting and may be relying on them to perform. In the current web-based observational study, we extend this research by comparing participants in two separate cultures, one (UK) characterized by a high degree of individuality and personal independence, and one (India) characterized by a high degree of collectivism and interpersonal interdependence. Participants viewed video clips of two agents making independent individual contributions to a joint action. When asked to imagine themselves in the observed scenario, participants in the UK indicated a greater self-reported sense of commitment to persist in the joint action, but lower expectations about others' sense of commitment to persist. Most strikingly, participants in India were nearly ten times as likely to perceive an obligation to persist in helping in the observed scenario.

EEG hyperscanning in a joint Simon task: a new approach to study joint action

P1

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In the last decades, the Joint Simon task (JST) has been extensively used to investigate the behavioral and neural correlates of co-representations during joint actions. Several studies associated the joint Simon effect (JSE) revealed by RTs analyses in joint action contexts with modulations of the N2 and P3 components, demonstrating the influence of the presence of a co-actor on brain activity. Nonetheless, the use of different experimental designs and statistical analyses in past studies prevents the formulation of a comprehensive description of how these components are associated with spatial correspondence and the turn-taking dynamics of the task. With a paradigm-driven approach, the present study aimed at filling this gap by analyzing both the amplitude and latency of the N2 and P3, recording the cortical activity of forty-four dyads performing a JST with a simultaneous EEG setup (hyperscanning). More importantly, the hyperscanning setup allowed us to characterize, for the first time, the temporal inter-brain dynamics of these components as measured by the computation of the JSE at a neural level for both the agent and the observer, demonstrating a synchronization between the EEG-JSE of co-agents at frontal and central sites.

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Face-to-face imitation is a fundamental social interaction wherein action and prior intentions are shared between individuals, and one of the critical factors for social learning and connectedness. In this study, we hypothesized that shared action and prior intentions are represented in different parts of mirror system and observed as inter-brain synchronization, and designed hyperscanning fMRI recording from two individuals during face-to-face imitation. Twenty-nine pairs of healthy volunteers performed the joint imitation task of writing in two MRI scanners. We controlled three experimental factors, prior intention, action intention, and role. An initiator was instructed to write two characters with their right index finger. A responder followed or unfollowed the initiator's action with shared prior intention or without. We analyzed inter-brain synchronization using beta-map correlation analysis. The results showed the inter-brain synchronization in the right premotor cortex (PM) when sharing action intention, whereas in the bilateral posterior superior temporal gyrus (pSTG) and the left motion-sensitive area, MT, when sharing prior intention. In conclusion, the right PM and the bilateral pSTG are the key areas for sharing action and prior intentions in imitative interaction.

Observer's traits predict accuracy of synchrony estimation and enjoyment of dyadic mirror-game movements

A

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Evidence that motor synchrony is a powerful form of social glue abounds: Matching another person's body movements can enhance one's affect, interpersonal rapport with one's partner, and prosocial behaviour more globally. But what about the influence of synchrony on an observer? Are we sensitive to the degree of motor synchrony in dyadic interactions? Can we quantify it accurately?

In this pre-registered study, we assess how accurately observers quantify the degree of synchrony in stick-figure dyads playing the mirror game, and whether synchrony is influenced by inter-individual differences in self-reported embodied expertise (ability to reproduce movements), psychosocial resources (extraversion, self-esteem, body awareness, and body competence), or social tendencies (empathy, autistic traits).

Preliminary analyses suggest observers quantify synchrony with high accuracy, particularly for highly predictable movements. Greater embodied expertise and enjoyment, as well as fewer autistic traits, are associated with improved accuracy. We also explored observers' enjoyment of synchronous dyadic movement, finding that enjoyment correlates positively with movement similarity and observers' extraversion, but negatively with movement predictability and observers' autistic traits.

In sum, observers' accuracy quantifying motor synchrony in dyadic movement is contingent on the movement predictability, notwithstanding observers' autistic traits, embodied expertise and enjoyment relating to the movements.

Transcranial random-noise stimulation in human-machine social interactions

K

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Most social neuroscience research is conducted on single participants who passively observe social stimuli, disregarding the dynamic aspects of social interaction. To overcome this limitation, interactive virtual partners (VPs) governed by mathematical models, have been developed. For instance, the Human Dynamic Clamp (HDC) is an experimental paradigm in which human participants coordinate their movements with a neuroinspired and adapting VP. Studies combining electroencephalography (EEG) and human-HDC interactions have identified key neuromarkers of sociality, specifically in the right temporoparietal junction (rTPJ). In parallel, the development of transcranial random noise stimulation (tRNS), a technique of electrical stimulation, has facilitated the transition from the study of neural correlates to causal inferences about brain mechanisms. The objectives of the study are to 1) modulate social behavior using tRNS over rTPJ and 2) develop real-time decoding algorithms of EEG activity to guide the stimulation. Results of behavioral synchrony with the HDC during rTPJ stimulation (vs. Sham) and decoding analyses of EEG data are presented and discussed. The combination of observational (EEG) and interventional (tRNS) methods provides a unique method for elucidating the neural mechanisms underlying our capacity for interactions. These results will pave the way for developing efficient closed-loop paradigms to better understand joint actions.

Utilitarian helping hands: self-serving support in small-scale interactions

B

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Two dimensions define collaborative motor interactions, a utilitarian and a social one. Indeed, interaction implies relating to another human (social dimension) whose contribution is needed to achieve a goal that could otherwise not be achieved (utilitarian dimension). We explored whether these dimensions modulate the tendency to correct a partner's mistake, shown by evidence that participants are slower after co-actor's errors but not when their action corresponds to what the co-actor should have done (corrective tendency effect). Participants ($N = 23$) were asked to play sequences of notes in turn-taking with a Human or Non-Human co-actor (social dimension), during an Interactive and Non-Interactive context (utilitarian dimension). In 50% of the trials the co-actor made a mistake. We found strong evidence for the corrective tendency effect only in the Interactive context but with both co-actors, as also replicated in an independent pre-registered experiment ($N = 24$). These results suggest that the utilitarian but not the social dimension of joint action shapes interpersonal behavioral adaptations. What counts most for the cognitive system is the relevance of the observed errors to the common goal achievement, independently of "who" made the mistake. Implications for the interaction with artificial agents will be discussed.

The Three Pillars of the Social Inhibition of Return Effect: The Task, the Partner, and the Context

D

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Social inhibition of return (SIOR) refers to the phenomenon in which there are slower reaction times toward locations already acted upon by the co-actor in a previous trial. Yet, it remains an open question how truly social the SIOR effect is. I will present aggregate evidence establishing the importance of the social factor in this task. We have examined the importance of the social factor by asking the following questions: whether merely believing that a partner exists would be a sufficient social cue to induce the SIOR effect; whether a co-actor's group affiliation would influence the SIOR effect; what the necessary social information is for this effect to be evoked; and finally, whether this social effect is modulated by reward properties. Evidence suggests that the social aspect is a necessary condition for SIOR and reinforces the theory that SIOR evolved to facilitate foraging by inhibiting redundant searches of already acted-upon locations by other people, regardless of any specific action.

The effects of an interpersonal social context on attention in a joint visual search paradigm

P1

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Joint action is pertinent to everyday life, though the attentional capture debate is still being addressed. The current study aimed to understand how the presence of others affects attentional allocation to information with pre-existing social value.

The experiment consisted of a modified replication of a visual search task investigating the interpersonal memory effect (He et al., 2011). Participants completed a joint visual search task online with a pre-programmed confederate. Assigned to image category cues that belonged to them, a confederate, or nonsocial baseline, participants searched for targets which did or did not flank cued images.

The study assessed how attention was allocated, thus whether information belonging to confederates were co-represented or inhibited. Results partially replicated the aforementioned study. A significant interaction between cue congruency and category cue was found specifically in the participant's category, and no effect in the confederate's condition, suggesting mechanisms of co-representation and inhibition.

Implications could advance understanding of attentional capture in joint action paradigms and inform understanding of this online. Future plans involve replicating this concept with joint action paradigms extending to conjunction search, in which multi-feature distractors with social or non-social salience are presented with targets to assess salience or inhibition of distractors.

Joint Sense of Agency and Self-Other Integration in Joint Action: Why Intentionality Matters

I

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Joint Sense of Agency (JSOA) is the feeling of control in joint action, over own and others actions. Previous studies suggest that JSOA is formed with co-agents that have a similar sensorimotor repertoire to a human. However, the intentionality attributed to a co-agent might also affect emergence of JSOA. In the current study, in two experiments, we employed a humanoid robot in a joint target-tracking-and-confirmation task. Participants estimated temporal intervals between confirmation actions and subsequent tones, while we recorded electroencephalography activity. Across experiments, we manipulated the intentionality attributed toward the robot, while keeping its sensorimotor repertoire similar to a human. Temporal estimates showed participants experienced JSOA only when acting with the robot presented as intentional. Moreover, when acting with the mechanical robot, participants' sensorimotor predictions, indexed by the N100 and theta connectivity, were more precise for self-generated than robot-generated outcomes. Conversely, when acting with the seemingly intentional robot, participants' sensorimotor predictions were similarly precise for self- and robot-generated outcomes, suggesting that when a co-agent is introduced as intentional, self- and other-forward models are better integrated into a joint model. Together, our results provide novel evidence that JSOA and joint sensorimotor processing are influenced by the perceived intentionality of the co-agent.

Predictive action planning and agency during joint action in human-human and human-robot interaction

P2

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Joint sense of agency (JSoA) refers to the control we feel over our own and our partner's actions in joint action. During joint action people make predictions about the actions and their sensory outcomes for themselves and their partners. These predictive processes are thought to underlie the JSoA, at least in part, and can be reflected by neural measures of anticipatory motor activity such as the readiness potential (RP). While JSoA is readily formed with a human partner, it may not always emerge while interacting with artificial agents such as humanoid robots. The aim of this work is to investigate the emergence of JSoA when participants engage in joint action with a human vs. the humanoid robot iCub. Participants will engage in a joint target-tracking-and-confirmation task with a human and a robot, during which we will collect interval estimates as a measure of implicit agency and EEG activity to extract the RP. Understanding the behavioural and neural mechanisms of JSoA when engaging in joint action with artificial agents can lead to valuable insights not only about how such agents can be involved in joint actions with humans, but can also reveal fundamental insights into the nature of human cognition.

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While an important body of work in philosophy and psychology has emphasized the importance of commitments in joint action, existing philosophical and empirical investigations of the experience of acting together have devoted little attention to the role that commitments might play in the emergence of a sense of joint action. I propose to explore three complementary ways in which commitments may shape the sense of joint agency and its main characteristics. First commitments may contribute to the generation of the sense of joint agency by stabilizing expectations and improving predictability. Second, commitments have a normative element that entitles the recipient of the commitment to perform regulatory actions—e.g., protesting—when the author fails to fulfill the expectations generated by their commitment. Such an entitlement may bolster an agent's sense of control over the joint action and help counterbalance the potentially disruptive effects of asymmetries among agents on the experience of joint agency. Finally, commitments may contribute to make acting jointly emotionally rewarding, both instrumentally, by improving coordination and making it easier to achieve desired outcomes, and intrinsically, by fostering circumstances under which shared emotions emerge among co-agents.

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Movement vigor changes with reward magnitude: movements exhibit shorter reaction time and increased velocity when directed toward more rewarding stimuli. But what if the reward is actively turned down? In interactive economic games, people turn down “free money” to punish players who have treated them unfairly. How vigorously do they move in punishing an unfair offer? Is vigor proportional to the incurred self-cost? Or does it rather reflect the cost inflicted to the unfair other? Here, we combined experimental economics and kinematics to investigate how self-cost, other-cost, and the effectiveness of punishments (i.e., the factor by which the self-cost reduces the punished player’s income) influence movement vigor. In two studies, we used motion capture to track the arm kinematics of participants while they played a motor version of the Ultimatum Game and the Trust Game. Results showed that as the reward magnitude increased, vigor increased for accepted offers, but decreased for rejected offers (Study 1). However, what was crucial in modulating vigor was not the self-cost or the other-cost, but their relationship, that is, the effectiveness of the punishment (Study 2). These findings imply that in deviating from optimal game theoretic predictions, participants accurately compute the cost of punishments.

The influence of social interactions on visuotactile causal and perceptual inference

P2

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When interacting with the environment humans need to integrate information coming from different senses. This is particularly relevant when interacting with other individuals of which we need to predict the movements in order to be able to coordinate with them. If and how interpersonal interactions based on different sensory channels differently modulate cross-modal interpersonal sensory integration processes, both at the behavioural and at the neural level, remains an open question and appears to be relevant to understand the mechanisms that contribute to establish a shared sensorial space between individuals coordinating with each-other in a motor task.

To study interpersonal multisensory integration mechanisms we asked pairs of participants to engage in three different behavioural tasks where they were asked to interact with the partner's hand movements at different degree of interactivity. After the interaction, we measured EEG and behavioural responses in order to investigate cross-modal interpersonal sensory integration processes and the visuo-tactile interference effects realized on ones' own and the partner's hand. We manipulated the number of visual and tactile stimuli presented together in order to investigate multisensory integration/segregation processes at different numerical disparities.

We quantified the confounding effect of the tactile stimuli on the visual percept of the participant by running a GLM analysis in order to obtain a visuo-tactile weight index. We further analysed the EEG evoked and oscillatory activity during the pre-stimulus interval.

We report that interpersonal interactions modulate cross-modal interpersonal integration processes in different ways depending on the degree of interactivity, and can be quantified both at the behavioural (visuo-tactile weight index) and neural (EEG) level. These results allow to set a possible sensorimotor base for the development of higher-order interpersonal processes.

Language use as joint action: people resolve interactional trouble in multimodal and co-efficient ways

E

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Meertens Institute

In everyday dialogues, people frequently encounter problems with perceiving or understanding talk, which they resolve by working together - a process known as other-initiated repair. I argue that we can use repair as a natural laboratory to study language use as joint action, as it is a conversational micro-environment which occurs at frequencies and timescales commensurate with the coordination of non-linguistic joint actions. I will present a study where we investigated repair at the level of the dyad, and in terms of multimodal utterances. We found that efforts in the spoken and gestural modalities are wielded in parallel across repair turns of different types, and that people repair conversational problems in the most cost-efficient way possible, minimizing the joint multimodal effort for the dyad as a whole. These results are in line with the principle of least collaborative effort in speech and with the reduction of joint costs in non-linguistic joint actions. Finally, I argue that repair can be used as a testing ground for joint action principles in diverse interaction contexts.

People tend to click with others

L

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Sometimes people meet and immediately click, such that there is rapid and strong social bonding from the very first moment. People tend to perceive clicking as a mutual and rare phenomenon, but is this the case? Is a click of a click a click, similar to a friend of a friend being a friend? First we tested the common intuition for the prevalence of clicking. Next, we recruited participants to play the Mirror Game, in which they had to move their hands as coordinately as possible. Across six datasets, we found that the clicking rate was about ten times the rate people intuitively assumed. Moreover, in contrast to the notion that click is mostly mutual, our results show that click is mutual in only about half the times. Finally, we found that a click of a click is not likely to be a click, implying that clicking may be more about the interaction than the individuals. We suggest that movement synchronization may lead to blurring between the self and the other and accordingly increase the tendency to click. However, this feeling of blurring may not be shared as is commonly believed. Nevertheless, people mutually click much more than they expect.

Obedience to Authority as an Asymmetrical Joint Action

P1

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Research on ‘obedience to authority’ revolves around the enigmatic question, of why and how participants comply with the demands of an authority figure even to the extent of a detrimental outcome for a third party. We argue that understanding obedience as an asymmetrical joint action can help with elucidating these questions. In two experiments, we tested this idea using an online ‘object-destruction paradigm’. Here, an experimenter instructed participants to press a key on their home keyboard to remotely crush bugs (among other objects) in a manipulated coffee grinder in the lab. We varied the degree of experimenter involvement in the object-destruction procedure. In Experiment 1, the experimenter always poured the objects into the destruction machine. Participants in the demand condition were ordered to destroy bugs, whereas participants in the control condition were reminded of their free choice. In Experiment 2, the demand condition of Experiment 1 was compared to a control condition in which participants had to remotely pour the bugs into the coffee grinder by themselves. Initial results suggest that more involved experimenters lead to higher obedience rates. These findings may point to possible links between joint action processes and social psychological phenomena and challenge prominent obedience explanations.

JAM (Joint Arousal Measure) Predicts the success of Ads, Auditions and Movies

L

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From lie detectors to apple watches, physiological sensors on the body have long been used to gain insight into the mind. They fail because there is not a simple correspondence between the two. A lowered heart rate could equally mean boredom or rapt attention. Rather than interpreting physiological changes of individuals, in our work we quantify the Joint Arousal Measures (JAM) within a group as a measure of engagement.

We find that the JAM of a trailer or advertisement can predict the global sales of a movie, the success of a kickstarter campaign, or the performance metrics of a TV ad. The success of an actor's audition is related to both the JAM between audience members watching, and the JAM between the actor and the audience.

In our experiments, participants watch a variety of video stimuli while wearing a physiological sensor on their finger. We calculate the temporal coordination between their electrodermal activity and heart rates using cross recurrence quantification methods. This JAM can then be compared across conditions, correlated with participants' explicit ratings or use to predict outcome measures of success.

In this talk, we will review the role that narrative, shared knowledge and social context play in engagement and physiological synchrony. We will explore the connection to work on hyper-scanning between individuals and the collective experience of audiences. Finally, we will discuss our attempts to use JAM to predict the outcome of the largest cultural event on the planet: the Eurovision Song Contest.

Low-latency real-time sonification as a novel paradigm in joint action research P1

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Joint actions often require individuals to simultaneously represent and monitor their own action outcomes as well as their partners'. One open question is how temporal coordination between partners is influenced by levels of attention towards individual versus joint action outcomes. A pilot study addressed this question in a joint action task in which partners synchronized spatial trajectories of finger movements along a pre-defined track by using sonification (a technique that uses sound to convey movement position) to guide attention. Partners' attention towards their individual versus joint action outcomes was manipulated via continuous sonification of either (1) each partner's spatial trajectory (Individual sonification condition) or (2) partners' spatial asynchrony (Joint sonification condition). Sonification was implemented using a low-cost dedicated audio device to sonify real-time 3D data from motion tracking cameras. Preliminary findings suggest that attention towards joint action outcomes enhances spatial-temporal coordination between partners, as indicated by smaller spatial offsets in the Joint condition relative to the Individual condition. Taken together, this pilot experiment showcases the implementation of sonification as a way to investigate synchrony in joint action, and has potential for broader applications in joint action research, including learning and learning optimization, interpersonal coordination and attention.

Does joint action coordination affect expectations of over-imitation in adults?

P1

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We learn not only by observing others doing things alone, but also by observing others acting together towards shared goals. In this study, we investigate how adults reason about individually and jointly performed action sequences, when such sequences involve goal-irrelevant elements. Although prior research has shown that people have a tendency to copy unnecessary actions - that is, to overimitate - (e.g., Lyons et al., 2007; Hoehl et al., 2019), the question remains whether this tendency also applies to joint actions and whether it can be revealed in the expectations observers have about others' imitative behavior. To that end, in an online study, we asked whether third-party observers are more likely to expect others to imitate goal-irrelevant actions, when such actions are produced in a joint context where two individuals coordinate their actions towards a shared instrumental goal, compared to actions produced individually and without coordination. Findings from this study reveal a more nuanced role of the cognitive mechanisms which support learning from a wide range of social interactions and provide insight into which features of joint actions play a key role in the successful transmission of cultural information.

Motor contagion of multiple agents: a kinematic analysis

B

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Observing other people's actions induces a motor contagion effect, visible in the kinematic unfolding of our own movements: we become kinematically more similar to the actions that we observe, even if this is detrimental to our own task. Is this effect modulated by the number of agents performing the actions? In the present study, we investigated this question by eliciting motor contagion within a Virtual Reality environment, where participants were asked to draw shapes in the air together with two virtual avatars, who could either draw the same, or an incongruent shape compared to them. Actions could be performed from either both or only one of the avatars. Participants' movements were recorded through a motion capture system and analyzed to extract a measure of similarity between the performed and the observed kinematic profiles. Preliminary data show that observing multiple agents' actions elicits an enhanced kinematic contagion effect, compared to observing only one agent. This enhanced similarity is specifically related to the kinematic incongruency of the observed actions. This study provides initial evidence for an enhanced low-level kinematic contagion effect in groups, which may allow us to start explaining social conformity phenomena from a motor perspective.

Embodied Joint Agency in Human - Robot Interaction

P2

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Artificial Intelligence-based technologies such as robots are developing at an unprecedented speed in our societies, considerably impacting human lives. In order to better understand this impact, we need to investigate the effect of interacting with these technologies on human mental and social lives. This project will focus on the relationship between the sense of embodied selfhood and social joint agency in human-human versus human-humanoid robot interactions. In doing so, behavioral, physiological and self-reports will be collected during a joint task performed in dyads of either two humans or a human and a humanoid robot. The joint task to be conducted will be a joint Simon task combined with an intentional binding task. Our aim is to unravel how humans' sense of body ownership and agency differs during interactions with a humanoid robot compared to another human being. The results will further our understanding of how humans are affected mentally and socially by interacting with artificial agents.

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Creative exploration often demands ‘going to the unknown’. Attachment Theory suggests that the presence (real or imaginary) of a security-inducing figure is supportive for exploration. We tested the hypothesis that the imaginary presence of a security-inducing person also supports creative exploration.

To achieve this, we applied an empirical paradigm for identifying exploration periods in a bounded search space, the Creative Foraging Game (CFG). Participants (N=129) moved 10 tiles on a computer screen, searching for shapes they find “beautiful and interesting”, in two conditions. The secure priming group was asked to vividly imagine a real security-inducing person (e.g., “grad-mama Sara”) and write down her name, which then appeared throughout the game. In the control condition participants imagined and wrote the name of someone they know (“Josh from IT”).

People with less secure attachment styles (high avoidance or anxiety) performed less creative exploration in the CFG. For people with high avoidance (but not for high anxiety), the secure priming mitigated this effect. Our results show that empirically triggering attachment-related mechanism enhance creative exploration for people with avoidance attachment style, and opens the way to a better understanding of how security provided by the presence of another can support creative exploration.

Spontaneous Emergence of the Joint Memory Effect in Visual Search

D

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Previous studies found that co-representation emerges without cooperative or competitive contexts and leads to memory formation of a partner's action target (i.e., the joint memory effect). However, in these studies, participant pairs simultaneously attended to one single object, which assumingly triggers altercentric cognition. We investigated whether this simultaneous attending is necessary and how the joint memory serves the future. Each participant from pairs were allocated to one of three target categories and searched for them in parallel. The same search layout was repeatedly presented, and it can form associative memory with the target location which shortens search time. Followingly, a surprise recognition test about search items was conducted in Experiment 1. As results, the partner's target was better recognized than the target nobody searched. In Experiments 2a and 2b, the test was replaced with the target transfer search, where one participant from each pair searched what the partner had searched while the other searched what nobody had searched. Results did not show shortened search time for the partner's target. These results suggest that simultaneous attending was not always necessary for the joint memory effect. However, the joint memory effect may not necessarily serve the future search.

Reading Between the Heartbeats: Exploring Self and Other Interoceptive abilities in Inferring Others' Bodily Signals

P2

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By grounding the self in the body, experimental psychology has taken the body as the starting point for understanding how we perceive others. A key piece of evidence in self-other mechanism highlighted the importance of one's own body states in understanding others, suggesting the existence of a mirroring mechanism in action/emotion. Galvez-Pol et al. (2022) found that people can judge the likely owner of a sequence of heartbeats better than chance based on visual cues, which raises questions about which self and other processes underlie the ability of humans to infer bodily states from visual information only. We conducted a study to determine if this ability depends on the interoceptive skill of both the observer and the observed person. We designed a two-alternative forced-choice task in which 20 participants had to guess the owner of a set of heartbeats by watching videos showing two people side-by-side in two different conditions (frontal and back perspective) and visual feedback of the heartbeats of one of the individuals in the center. Preliminary results show that neither the observer's nor the observed person's interoceptive abilities influence performance. Surprisingly, participants are significantly better at guessing the owner of the heartbeat when looking at people from behind. While the mechanism remains unknown, we speculate that people may be overloaded with information in the frontal condition.

How sure are you? Kinematic readout of confidence in collective decision-making

P1

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Research on collective decision-making has shown that groups can outperform their best individual members through “confidence sharing”: individuals communicate how confident they felt in their individual judgements so as to arrive at a collective decision [1]. However, such explicit communication of confidence estimates can be noisy, biased, and cognitively demanding [2,3]. Yet, replacing interpersonal communication by simple heuristics also comes with difficulties [3]. In the present study, we put forward another, implicit way of confidence sharing. We test the hypothesis that, in the absence of explicit communication, two individuals are able to infer each other’s subjective confidence through simple action observation [4,5], and thereby achieve a group benefit. To this end, we ask two participants to solve a 2AFC perceptual task, with individual decisions being followed by a collective decision. Participants indicate their decisions by performing observable aiming movements to one of two targets [5], while movement kinematics are recorded. Preliminary results from a pilot study suggest that individuals read out confidence from each other’s movements and rely on this inferred confidence in the collective decision-making process. With data acquisition still ongoing, we expect the final results to reveal how action observation can inform collective decision-making.

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Can a Joint Action with a Robot Lead to Shared Body Representation?

P1

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Hands are the tool with which we accomplish most of our tasks. Previous studies revealed that human attention is prioritized to the space near the hands, the so-called “near-hand effect” [1], [2]. In human dyads, this effect may also occur towards the partner's hand, but only after sharing a physical joint action [3]. Hence, interaction leads to a shared body representation that may influence basic attentional mechanisms. Our project investigates whether a similar effect can be triggered by the hand of the humanoid robot iCub [4]. We discovered that the mere presence of the iCub's anthropomorphic hand is not enough to provoke the near-hand effect [5]. Hence, we designed an experiment to evaluate whether a collaborative joint action with the iCub might cause the near-hand effect. We will replicate a human-human collaborative task in an HRI setting. The participant and the robot will cut a soap bar together using a steel wire. They will hold one end of the wire each and try to coordinate to optimize the result, exchanging forces through the wire. The appearance of the near-hand effect towards the robot's hand after the interaction would mean the HRI can recreate the shared body representation emerging from human dyads.

Sharing action and prior intentions during imitative interaction: a hyperscanning fMRI study

G

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Hyperscanning studies have mostly employed bivariate analysis techniques to measure neural coupling between interacting brains. Since the interaction of two brains is significantly more complicated than comparing the activation of specific channels or Region of Interest (ROIs), we argue that these studies have overlooked the multivariate nature of interaction. Therefore, it is essential to employ multivariate analysis which allows to depict the complex inter-brain connectivity. Graph theory is one such method which builds a network that includes all information sources, revealing patterns of connectivity between channels and regions of interest (ROI) as well as information exchange among participants.

Here, we reviewed recent literature hyperscanning studies employing neuroimaging techniques (EEG, fNIRS and fMRI). More specifically, we discuss the benefits of using graph theory-based methodologies for hyperscanning. We further highlight some relevant graph theory measures for hyperscanning such as Interbrain density (IBD), divisibility, and modularity. We conclude that these measures are sensitive to brain-to-brain networks and can provide insights into asymmetries between participants. Further, we conclude that combining graph theory with machine learning techniques can help us understand the organization of healthy or diseased brain and enable more accurate diagnosis and prognosis.

Motor inhibition in joint action tasks with humans and robots

P1

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Motor inhibition allows for efficient cooperation. Prior work demonstrated that people required more time to inhibit an ongoing action jointly with a partner (i.e., opening a bottle that a co-actor is holding), compared with doing it individually. This is presumably due to the need of processing partner's and our own actions simultaneously. However, it is unclear whether this is due to social or motor feedback provided by the partner. Here, we explored whether performing a joint-motor task with a partner instructed to not display any social feedback would yield similar effects. 32 participants opened a bottle held by a human co-actor or a mechanical clamp. On 33% of the trials, they heard a tone to instruct them to inhibit their action. Results showed slower motor inhibition with the human compared to the clamp. This suggests that social feedback is not necessary to slow down motor inhibition. As a follow-up, 31 participants performed the task with a humanoid robot, to guarantee that both social signals and motor feedback were not delivered. Results showed no differences in motor inhibition between robot and clamp. This suggests that motor feedback might be crucial for motor inhibition in a joint-motor task.

Impact of Emotion on Spontaneous and Intentional Interpersonal Synchronisation

P1

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Human interaction entails the coordination of actions in time. Much research effort has been invested in expounding on rhythm adaptations, but the effect of systematically induced emotions on interpersonal synchronisation remains unclear. To address this problem, we conducted a series of experiments in which we induced emotions with success-failure manipulations and quantified the resulting synchronisation changes. In the first experiment, groups of three participants spontaneously synchronised during a joint improvisational dancing task. In the second experiment, groups of three participants intentionally synchronised during a seated air finger-tapping task. Our results demonstrated that ecologically induced emotions produce discernable changes in movement synchronisation. In fact, the results of the first experiment, in which the task was personally relevant (i.e., dancing for dancers), showed improved synchronisation scores after positive emotion induction. In contrast, the results of the second experiment, in which the task was not personally relevant (i.e., air finger-tapping task), evidenced impaired synchronisation tendency after negative emotion induction. We didn't, however, detect substantial differences in physiological activity throughout different joint actions. We discuss implications for joint action research and applied outcomes for human-machine interactions.

Building demonstrations from scratch: Understanding pedagogical communication in teaching interactions

E

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Communication during joint action allows for the mutual exchange of information to support ongoing coordination between partners, and is particularly important in interactions where one individual must teach the other how to perform the relevant skill. Communicating a novel skill to a naive learner is highly challenging, and teachers may often use their own history of social learning (instruction, observation) to inform their decisions about how to teach. It is an open question how teachers approach pedagogical communication when their only experience of the skill is through individual learning, and the decision of how to teach it is entirely up to them. We present a study where participants first learned a motor timing task (Individual Learning) with two timing targets—absolute and relative timing—and then produced demonstrations emphasising one of the two targets. Results show considerable heterogeneity in Individual Learning outcomes of relative timing that was associated with specific kinematic features of participants' movements. Furthermore, participants who learned this relative timing better then modulated these same kinematic parameters specifically when demonstrating the task for a new learner. Teachers recognise the task-relevant information they acquire through individual learning and strategically modulate this to communicate skills to naive learners.

Empathy increases social bonding in interpersonal interactions that feature music and influences the pleasurable urge to move to music

C

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Music is a social activity. It is predominantly created in groups and for groups, where it can induce synchronized movements and align emotional perception and expression. The social nature of music links it to empathy - the understanding and sharing of feelings and experiences of others. We investigated whether individuals with higher trait empathy experience stronger interpersonal closeness in movement interactions that feature music. In two experiments, participants rated the closeness toward a virtual partner who was moving temporally aligned or misaligned with the beat of music or a metronome. We found that higher trait empathy was associated with stronger social bonding. Significant interactions in both experiments indicated that participants with lower empathy felt more connected when interacting with a metronome compared to music and that their ratings of social connectedness differed less between an aligned vs. misaligned virtual other. In an additional pilot experiment, we showed that the pleasurable urge to move to music increases with increasing trait empathy. Interestingly, this increase was more pronounced for stimuli with low and high rhythmic complexity and less pronounced for medium rhythmic complexity. In general, these findings suggest that empathy plays a multifaceted role in how we enjoy, interpret, and use music.

Effort-Based Decision Making in Joint Action: P1 Evidence of a Sense of Fairness

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As humans, we are unique with respect to the flexibility and scope of our cooperative behavior. In recent years, considerable research has been devoted to investigating the psychological mechanisms which support this. One key finding is that people frequently calibrate their effort level to match a cooperation partner's effort costs - although little is known about exactly why they do so. We hypothesized that people calibrate do so with the ultimate goal of attracting and keeping good collaboration partners, with the proximal psychological motive being a preference for fairness. Across three lab-based, pre-registered experiments (N=100), we found support for these hypotheses, and ruled out plausible alternative explanations, such as the conjecture that people may use their partner's effort costs as information to infer the value of opportunities afforded by their environment, and the conjecture that people may calibrate their effort investment in order to appear competent.

Do listeners use speakers' iconic hand gestures to predict upcoming words?

J

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During face-to-face conversation, people rapidly take turns talking and use hand gestures that depict semantic meaning in addition to speech. In this pre-registered EEG study, we investigated whether listeners use speakers' hand gestures to predict upcoming words. Participants listened to questions asked by a virtual avatar. Each question was accompanied by an iconic gesture (or control self-adaptor movement) that preceded a short silent pause and a target word. During the pause, participants showed stronger alpha and beta desynchronization in the Gesture versus the Adaptor condition, which have been reported as markers of anticipation. Moreover, gestures facilitated semantic processing of target words, as shown by less negative N400 amplitudes. A Cloze test with separate participants showed that seeing the gestures improved explicit predictions of the target words. However, how much each gesture improved predictions in the Cloze test was not related to the alpha and beta desynchronization in the EEG experiment. Altogether, these results are in line with the idea that listeners can use speakers' iconic gesture to predict upcoming words, which may facilitate coordination during conversational turn-taking by enabling earlier response planning. However, it is unclear to what extent pre-stimulus alpha and beta desynchronization reflect predictive processing.

Synchrony, synergy and sense of joint action in naturalistic social coordination: the case of Lindy Hop partner dancing

P2

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In experimental research on joint action and coordination, synchrony (similar temporal ordering of actions) is often used as an operationalization of coordination, which then can be related to measures of joint agency. This is appropriate in simple, goal-directed contexts where synchrony is the explicit goal. In this project, however, we demonstrate that research on joint action and dynamic social interaction can move beyond these experimental and measurement limitations, using improvised (Lindy Hop) partner dancing as a case of social coordination that is physically measurable with motion capture technology, as well as naturalistic and open-ended.

In this study, we introduce synergy (the degree to which coupled systems form an emergent whole, with predictive information beyond that of constituent parts) as an important quality of movement coordination, which can be operationalized with tools from information theory. We investigate to which degree partner dancing is synergetic, as well as the relationship between synchrony, synergy, and sense of joint agency, as modulated by leader-follower dynamics.

Preliminary results confirm nested timescales of shared rhythmical entrainment to music. There are indications of distributed leading dynamics where the follower leads the rhythmical entrainment, and of suspensions of rhythm being used as coordination cues.

The ‘microstructure’ of interpersonal neurobehavioral coordination

P2

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Most animal species coordinate their behavior in quite sophisticated manners for mating, hunting, or defense purposes. In humans, the neurobehavioral substrates of this ability have been mainly addressed by focusing on the macroscopic structure of movement coordination. That is, the spontaneous or intentional production of coordinated movements along a natural, task-related or negotiated pace. By examining the fine structure of movement, we have recently shown that interpersonal coordination is also established at a lower, microscopic level. It is known that periodic (2-3 Hz) pulses are naturally engraved in our motor output. These subtle but highly consistent kinematic/force discontinuities, otherwise called submovements, have long been observed in behavior and explained as corrections ensuing from intermittency in the closing of visuomotor control loops. In a series of interpersonal and intrapersonal coordination tasks (actual movement or isometric force control) that also involved dual-EEG recordings, we showed that submovements generated by interacting partners are not independent but alternate tightly over time as if reflecting rapid, reciprocal online adjustments. These findings unveil a potential core mechanism for neurobehavioral coordination that is based on between-persons synchronisation of the intrinsic dynamics of action-perception cycles.

Co-actors integrate the costs of different types of actions in joint action planning

H

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In repeated joint actions, people take the expected group effort into account and choose action options that minimize it (i.e., are co-efficient). This study investigated how people plan joint action sequences when co-efficiency would require the integration of the costs of different types of actions. In a within-subjects experiment, participants (N=40) played a touchscreen-based game in which they collected objects by choosing one of two actions (tapping or dragging). We manipulated the number of taps and lengths of paths to be dragged over. We measured the participants' tapping and dragging durations, estimated the individual relative costs of these actions, and evaluated their efficiency in a 2AFC condition. We then analyzed participants' decision-making when the same task was embedded in a joint context. When playing alone, the participants tended to minimize movement durations. Decisions in the joint task were best explained by a model incorporating both the decision-maker's and the co-actor's relative action costs: The higher the combined costs of a dyad's tap-and-drag sequence, the less likely that it was the chosen course of action. Thus, conditional on individually efficient decision-making, people integrate the relative costs of different actions available to themselves and their partner in joint action planning.

Co-efficiency as a potential focal point in coordination problems

P2

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We investigated whether people use co-efficiency as a focal point when they lack information about their partners' decisions in repeated coordination games. In two online experiments (N=50 in each), participants collected object pairs with a remote partner. They were told that each object choice that matched with the partner's would score a point, but no feedback was provided about the decisions of the partner. We analyzed object choices regarding their co-efficiency and other potentially salient features. In both experiments, choices were best explained by models including the participant's and the partner's individual action costs, and the initial distance between an object and the participant's cursor. Co-efficient choice proportions positively correlated with coordination success: The more often participants chose co-efficient objects, the likelier their choices were to match with other participants' choices. Co-efficient object pairs tended to be recognized as focal points by some even when they were not required to perform the action sequences (Experiment 2), although this effect was smaller than in the case of the "real" action sequences, where the effect was moderate (Experiment 1). These findings indicate that co-efficiency could act as an abstract rule to select focal points for coordination.

Experiences of united agency in joint action: P1 Where, when, and why?

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When people engage in joint actions such as group music-making, dancing, or marching, they sometimes experience a sense of “acting as one” or “acting together as though a single unit”, referred to as united agency. Little research has systematically examined people’s experiences of united agency when they engage in joint actions in their everyday lives. The current study filled this gap by collecting detailed descriptions of united agency experiences from 105 participants using an online survey. Findings indicated that 1) a majority of the participants experienced united agency at least occasionally, 2) united agency often occurred in sports and exercise-related activities and musical activities (dancing, playing, or listening to music), and 3) united agency occurred across a variety of group sizes, experience levels, and interpersonal relationships. Furthermore, the frequency of experiencing united agency was correlated with cognitive empathy, extraversion, and agreeableness, and experiencing united agency elicited a variety of cognitive and emotional responses. These findings shed light on the conditions under which united agency is likely to occur as well as its positive social and emotional consequences.

Differences in Partner Empathy are Associated with Interpersonal Kinetic and Prosodic Entrainment During Conversation

P1

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During conversation, speakers coordinate and synergize their behaviors at multiple levels, and in different ways. Speakers may coordinate complementarily, such as providing a response to a question, or they may entrain or align their behaviors, such as converging on similar words or postures. Interpersonal coordination may also be influenced by dyad-level factors, such as differences in empathy (i.e., double-empathy problem). We investigated this possibility in a corpus of unconstrained dyadic conversation, focusing on speech and bodily movement (captured using video-based motion tracking) during qualitatively-determined question-response sequences. We used dynamic time warping to quantify (dis)similarity of head and hand motion (i.e., kinetic entrainment), and correlation between mean f0 of speech (i.e., prosodic matching), during the uttering of question-response sequences. We calculated differences in empathy quotient (EQ) scores, and assessed the correlation of this difference with the kinetic and prosodic entrainment variables. For both the head and hands, greater difference in EQ was associated with lower asynchrony (i.e., greater entrainment). No association between EQ difference and prosodic matching was found. Thus, while in engaging in complementary actions at the level of turn sequences (i.e., question-response sequences), people who are dissimilar in EQ may need to “ground” their interaction with low-level movement similarity.

Investigating the Multimodal Compositionality and Comprehension of Intended Meanings Using Virtual Agents

E

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Communicating intentions is fundamental to the joint action of conversation. To do so, we must recognize and respond to the pragmatic function of an utterance in a socially contingent manner. For example, a criticism produced as a question will afford a different response than a genuine request for information. Little is known about how visual signals that accompany face-to-face conversation contribute to communicating intentions, how individual signals combine into more complex, holistic Gestalts, and how they influence comprehension. In this ongoing study (to be completed in time for the conference), we investigate these issues using an animated virtual agent uttering questions while producing various (combinations of) visual signals. Specifically, head tilts, head turns, eyebrow raises, and all combinations of these three signals, for a total of seven visual Gestalts of interest, plus five “filler” conditions. After each video, participants must identify, from six categories, the intended meaning of the utterance (e.g., information-seeking question, criticism, skepticism, clarification question). Results will inform our understanding of the multimodal composition and processing of intentions in face-to-face dialogue, and the extent to which visual signals shape the coordination of joint actions by modulating the type of next-turn responses they make socially relevant.

Towards a Mechanism of Semantic Interference Removal in the Joint Picture-Word Interference Paradigm

P2

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Recent studies have removed semantic interference using joint versions of the picture-word interference (PWI) paradigm (e.g., Sellaro et al., 2020). In the standard PWI task, participants respond to target pictures while ignoring distractor words. If words are semantically related to pictures, responses are slowed. In joint versions of the PWI, participants still respond to pictures, but a partner responds to the words. In such scenarios, mean response latencies on related relative to unrelated trials are equated, and in some cases facilitated. Tufft and Richardson (2020) offer a social offloading account of interference removal, where joint working affords opportunities to downregulate the influence of distractors. Alternatively, Kuhlen and Abdel Rahman (2022) propose a social communicative explanation, where processing of conceptual relationships between pictures and words is enhanced in dialogue-like settings. In this study, we contrast these positions by embedding the joint PWI in contexts that emphasise conceptual relationships or do not. Our results replicate interference removal in social contexts, but crucially this did not depend on the conceptual context. While such patterns of removal are consistent with social offloading, we propose important steps to understand in which settings the partner's task is not only offloaded but used to facilitate own action.

Join the action: top-down and bottom-up information modulate different neurophysiological indexes

P1

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During Joint Action (JA), prior knowledge is integrated with the online extraction of partners' kinematic cues to optimize motor coordination. We designed a transcranial magnetic stimulation (TMS) study to investigate the neurophysiological fingerprints of these two processes. Subjects were required to perform a normally bimanual task - opening a bottle -, unimanually with the necessary collaboration of a partner. The participant held one of two bottles, while the confederate had to reach and open one of the two. We manipulated the availability of prior knowledge with a visual cue indicating which of the two bottles was going to be used.

Single-pulse TMS was delivered over the left primary motor cortex to collect motor evoked potentials (MEP) and cortical silent periods (cSP) from the opponens pollicis (OP). The TMS pulse was delivered in four timings: rest, confederate's movement onset, pre-shaping, grasping. The availability of prior information modulates CSE. Instead, cSP is modulated by kinematic cues when accessible. The concurrent activation of two inferential processes during JA, one encoding contextual priors while the other reflecting online information sampling, is reflected in CSE and cSP. These indexes, might constitute the neurophysiological fingerprint of these two complementary processes, naturally at play during social motor interaction.

Do chimpanzees (*Pan Troglodytes*) form co-representations in a collective enumeration task?

P2

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Co-representations, - an ability to represent another's actions, are believed to play a crucial role in enabling joint action. While this mechanism is hypothesized to have played a significant role in the evolution of human social cognition, its evolutionary origins are still poorly understood. Several non-human primate species have demonstrated evidence of co-representations in a joint task (Miss & Burkart, 2018; Miss et al., 2022), but no such evidence has existed for great apes.

We asked whether chimpanzees (*Pan Troglodytes*) would show evidence of co-representations in a collective enumeration task. Paired subjects took turns in selecting four numbers in ascending order on a shared touch-screen. Numbers on one side of the screen were in blue, and on another - in red. On confusing trials the target numbers appeared in the partner's color. On control trials the target numbers appeared in green (neutral) color. We hypothesized that persistent co-representations would slow down responses to confusing stimuli due to color-side conflict. Our data from a pilot study suggests that at least one chimpanzee subject treated confusing stimuli differently compared to regular and control stimuli. We will complement our results with data from a simulated partner condition and a human partner condition.

Offloading under cognitive load: Humans are willing to offload parts of an attentionally demanding task to an algorithm I

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In the near future, humans will increasingly be required to offload tasks to artificial agents to facilitate daily and professional activities. Yet, research has shown that humans are often averse to offloading tasks to algorithms (so-called “algorithmic aversion”). In the present study, we asked whether this aversion is also present when humans act under high cognitive load. Participants first performed a multiple object tracking task alone (Solo condition) and were then given the choice to offload an unlimited number of targets to a computer partner (Joint condition). We found that participants significantly offloaded some (but not all) targets to the computer partner, thereby improving their individual tracking accuracy (Experiment 1). A similar tendency for offloading was observed when participants were informed beforehand that the computer partner’s tracking accuracy was flawless (Experiment 2). The present findings show that humans are willing to (partially) offload task demands to an algorithm to reduce their own cognitive load. We suggest that the cognitive load of a task is an important factor to consider when evaluating human tendencies for offloading cognition onto artificial systems in human-AI interactions.

Try to see it my way: Humans Take the Level-1 Visual Perspective of Humanoid Robot Avatars

P1

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Visual perspective taking (VPT) is a fundamental process of social cognition. To date, few studies have investigated whether humans also take the perspective of humanoid robots. Recent findings are conflicting as one study found no evidence for level 1 VPT (i.e., which object is seen by the robot) and a different study found evidence for level 2 VPT (i.e., how is the object seen by the robot). These results are puzzling as level 1 VPT is a foundational ability for level 2 VPT. The latter study proposed that the mere human-like appearance of robots triggers VPT (mere-appearance hypothesis). Here, we tested level 1 VPT for humanoid robots and the robustness of the mere-appearance hypothesis. We manipulated the human-like appearance of the robot and the robot's mental capacity to perceive its environment. We found that all manipulations triggered VPT, showing, in contrast to earlier findings, level 1 VPT for robots. Also, our findings support the mere-appearance hypothesis as VPT was triggered regardless of whether the robot had a mental capacity to perceive its environment or not and we show that the mere-appearance hypothesis is robust with regard to alterations of human-like appearance.

How to quantify interpersonal synchrony in autism using wearable sensors

A

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People often spontaneously synchronise with one other during social interactions, but this synchrony is not always present in autism. There are few methods available for measuring social synchrony outside the lab, which makes it hard to know what natural patterns of synchrony should look like.

Here we present a system of wrist-worn movement sensors and a measure of interpersonal synchrony, which we use to uncover social behaviours in young autistic people with learning difficulties. We used Fitbit-like sensors to collect data from 16 autistic and 12 neurotypical children interacting with one other and 8 adults across 5 separate groups during school activities. Cross-wavelet coherence analysis was used to calculate interpersonal synchrony between over 200 pairings, providing a convenient estimate of social engagement.

We compare our measures to blind independent video ratings of social engagement and find a clear positive correlation, which validates the use of sensors for in-the-wild studies of social behaviour in autism. Second, we compare levels of synchrony across different age groups to characterise patterns of spontaneous social interactions which arise in real-world classroom settings. The results show how wearable sensors enable a new type of research on real-world social interactions and advance our understanding of social synchrony.

Does interpersonal synchrony reduce self-other distinction?

P2

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Moving in time with others has been shown to lead to increased cooperation, stronger affiliation, and better coordination between co-actors. One of the proposed mechanisms underlying these effects is an increase in self-other overlap, or a decrease in self-other distinction, induced by the performance of the same movements at the same time as another person. Across three pilot studies, we investigated whether interpersonal synchrony modulates motor-level self-other distinction and perceived self-other overlap. Participants (N=40) performed a coordination task, in which they moved either synchronously or asynchronously with a task partner. They then completed an imitation-inhibition task, measuring motor-level self-other distinction, and a continuous version of the Inclusion of Other in Self scale, quantifying perceived self-other overlap. We predicted that after synchronous compared to asynchronous coordination, participants would show a stronger tendency to imitate their task partner, and that they would report a higher percentage of perceived overlap with their task partner. However, we did not find an increase in imitation of the task partner's hand movements after synchronous coordination, nor did participants indicate a higher percentage of perceived overlap. This suggests that interpersonal synchrony may have a smaller effect on motor-level self-other distinction and perceived self-other overlap than previously assumed.

Human-machine interactions as joint actions and their moral consequences

P1

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We will soon be sharing our social life with artificial systems, and it is conceivable that we will naturally respond to such interactions as social interactions. We argue that certain human-machine interactions cannot satisfactorily be reduced to mere tool-use because artificial systems such as learning algorithms or social robots are able to act with some degree of autonomy, learn from experience, adapt their goals correspondingly, and react to social cues. If artificial systems, unlike mere tools, do more than just behave, then they might be able to act jointly with human counterparts.

Assuming a gradual understanding of joint actions, we show that a minimal approach presents a promising starting point to expand our conceptual framework to capture such interesting in-between phenomena. In a second step, we show how taking an AI-stance (Strasser & Wilby 2023) can do justice to questions regarding critical issues of moral responsibility. Finally, we argue that we need to understand moral praise and blame in a specific, minimalist way when it comes to those human-machine interactions.

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How do work songs stabilize the tempo of rhythmic joint actions?

C

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Recent research has shown that people engaged in rhythmic interactions have a strong tendency to increase their tempo; the phenomenon of joint rushing. However, successful joint action often requires interpersonal coordination at a stable tempo. One way to achieve a stable tempo despite the joint rushing tendency is the use of vocalizations as observed in actual work songs accompanying straining joint actions. Two characteristics of actual work songs may be particularly effective: the use of solo passages and metric subdivisions of the intervals between instrumental actions.

The aim of the present study was to test whether these two characteristics help pairs of participants to overcome joint rushing and to maintain a target tempo.

Participants performed a joint synchronization-continuation finger tapping task, in which they first synchronized with a fading metronome and then continued tapping, while vocalizing numbers.

In three experiments we tested the effect of solo counting and metric subdivisions separately, as well as in combination. Only solo counting and subdivisions combined helped participants to maintain the target tempo.

The results indicate that vocalizations can indeed stabilize the tempo of rhythmic joint actions. There may also be other aspects of work songs that can support achieving joint goals.

Communication and action predictability: two complementary strategies for successful cooperation

E

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Making one's actions predictable and communicating what one intends to do are two strategies to achieve interpersonal coordination. It is less clear whether the two strategies of achieving coordination are mutually exclusive or whether they can be used in parallel. Here, we asked how the availability of communication channels affects the use of making one's actions predictable. In three experiments, we investigated how people reach joint decisions if they are not allowed to communicate at all (Experiment 1), allowed minimal reciprocal communication (Experiment 2), or allowed to use the full range of conventional communication (Experiment 3). We found that when participants were not allowed to communicate coordination was achieved by increasing action predictability. When conventional communication was allowed there were no attempts to increase action predictability. In the minimal reciprocal communication condition, successful pairs both increased action predictability and established a communication system. Overall, the present study demonstrates that people are able to flexibly adapt to coordination challenges during joint decision making and that communication reduces behavioral constraints on joint action coordination.

Social coordination in and out of synchrony: How do groups implement joint musical actions?

A

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Rhythm can provide a scaffolding for social interaction that allows partners to predict one another's actions and coordinate accordingly. Mechanisms by which partners predict one another during rhythmic interactions, like oscillator coupling, linear phase correction and others, have been extensively investigated. However, it remains unclear how partners coordinate the timing of actions in the absence of rhythm, such as when pauses occur in human communication. For example, how do conversation partners determine how long to wait between turns? How do jazz improvisation partners synchronize timing of expressive pauses between musical phrases? And how do larger groups solve the problem of ending pauses in interaction, when there are many possible actors who could end a pause? Here we address these questions in the context of musical communication, which affords direct comparisons between rhythmically structured and unstructured interaction. We designed a novel musical interaction paradigm in which groups of ten musicians produce rhythms interleaved with unstructured silences in three tasks: produce rhythms (1) synchronously in a group, (2) individually, and (3) observe one another producing rhythms. Group synchronization, individual production, and observation tasks will be compared to assess whether rhythmicity of pauses in communication spontaneously emerges during social coordination.

Coordinating Joint Action in a Novel Complex Real-world Task

P2

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People are not as strong or as fast as the creatures surrounding us. Our advantage is cooperation. Joint action begins early, alternate babbling, clapping games, hide-and-seek, setting the foundation, turn-taking, imitation, and trust. With age, joint actions increase in complementarity and complexity, as well as coordination. Many coordination mechanisms have been studied in modular tasks but so far not in extended novel complex everyday tasks. To gain insight into how coordination is established and maintained in such a task we analyzed speech, gesture, and action as pairs of strangers assembled a piece of furniture guided by a photograph of the completed TV cart. At planning, dyads used speech and some gesture to establish a joint mental model of the cart's structure, the goal. Speech was rarely used to refer to actions or to actors. Throughout assembly, speech decreased as dyads relied primarily on assembly actions to coordinate. Actions did double duty, advancing the task and communicating the next step. Speech returned briefly on rare occasions when a mistake was made. The joint mental model of the goal allowed dyads to use actions to progress, to monitor progression, and to coordinate actions with little necessity for speech.

Interbrain synchronization underlying people's sense of joint agency during musical joint action

P2

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When people perform joint actions, they often experience a sense of joint agency, i.e., a sense of shared control over actions and their consequences. Researchers have recently begun to investigate the brain mechanisms underlying joint agency, with recent evidence suggesting that interbrain synchronization (IBS) might play a functional role in both interpersonal coordination and the sense of joint agency that accompanies it. The current study used EEG hyperscanning to investigate IBS underlying joint agency during musical joint action. Pairs of participants used electronic music boxes to produce either musical duets (familiar melodies with supporting accompaniment) or constant pitch sequences (pitches spaced a twelfth apart) together. Participants rated their sense of joint agency after each sequence. IBS during sequence production was measured using the Phase Locking Value (PLV). Participants reported stronger joint agency, and IBS was greater in the theta frequency band (4-7 Hz) over left temporal-parietal regions, when partners produced musical duets compared to constant pitches sequences. These findings align with previous findings that theta-band IBS is associated with joint agency during turn-taking joint actions. The possible roles of IBS and interpersonal coordination as serial mediators of the relationship between joint musical outcomes and joint agency will also be discussed.