

XI. Dubrovnik Conference on Cognitive Science

23 – 26 May 2019, Dubrovnik, Croatia

Computational Rationality



Invited Speakers:

Ulrike Hahn (Birkbeck, University of London, UK)

Quentin Huys (Max Planck UCL Centre for Computational Psychiatry and Ageing Research, London, UK)

Julian Jara-Ettinger (Yale University, USA)

Máté Lengyel (University of Cambridge, UK, Central European University, Hungary)

Azzurra Ruggeri (Max Planck Institute for Human Development, Berlin, Germany)

Laura Schulz (Massachusetts Institute of Technology, USA)

Chairs:

Gergő Orbán, Oana Stanciu

Organisers:

Krisztina Andrási, Francesca Bonalumi, Gergely Csibra, Paula Fischer,
Barbu Revencu, Laura Schlingloff, Georgina Török

Centre for Advanced Academic Studies (CAAS), Dubrovnik
University of Zagreb

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Programme

23 May, Thursday

15.00 – 18.00 Registration

18.00 Welcome Reception

24 May, Friday

09.00 – 10.00 Invited Talk I: **Ulrike Hahn** -- How communication can make voters choose less well

10.00 – 11.30 I. Poster Session and Coffee break

11.30 – 12.30 Invited Talk II: **Máté Lengyel** -- A Bayesian Approach to Internal Models

12.30 – 14.30 Lunch

14.30 – 15.30 Invited Talk III: **Julian Jara-Ettinger** -- The mentalistic roots of human communication

15.30 – 17.00 II. Poster Session and Coffee break

18.00 Social Event

25 May, Saturday

- 09.00 – 10.00 Invited Talk IV: **Azzurra Ruggeri** -- The emergence and developmental trajectory of ecological and active learning
- 10.00 – 11.30 III. Poster Session and Coffee break
- 11.30 – 12.30 **Young Researchers' Presentations**
- Marie Aguirre** -- Toddlers are capable to anticipate the informativeness of their actions.
- Pablo Leon Villagra** -- Generalizing Functions in Sparse Domains
- Laura Schlingloff** -- Ten-month-olds do not expect agents to choose larger quantities of goal objects
- Ádám Koblinger** -- On the role of time in perceptual decision making
- 12.30 – 14.30 Lunch
- 14.30 – 15.30 Invited Talk V: **Quentin Huys** -- The irresistibility of sadness: towards the prediction of depression relapse after antidepressant discontinuation
- 15.30 – 16.00 Coffee break
- 16.00 – 17.00 Invited Talk VI: **Laura Schulz** -- The troubled mind: Some thoughts on how we solve problems -- and why we make them for ourselves
- 18.00 Farewell Reception

26 May, Sunday

Departure

Abstracts – Invited speakers

How communication can make voters choose less well

Ulrike Hahn

Birkbeck, University of London, UK

Recent political upheavals have returned focus to questions of ‘voter ignorance’ and the possibility that voters may sometimes vote against their own (in particular, economic) interests. Yet political scientists are quick to point out that voters have always been comparatively poorly informed. The talk describes simulations with an agent-based model which indicate how collectively, voters may have become less accurate, even where individual level accuracy has remained fairly unchanged. These simulations also shed tentative light on the ways in which the advent of social media may have impacted democratic societies.

A Bayesian Approach to Internal Models

Máté Lengyel

University of Cambridge, UK; Central European University, Hungary

Our percepts rely on an internal model of the environment, relating physical processes of the world to inputs received by our senses, and thus their veracity critically hinges upon how well this internal model is adapted to the statistical properties of the environment. We used a combination of Bayesian inference-based theory and novel data analysis techniques applied to a range of human behavioural experiments, as well as electrophysiological recordings from V1, to reveal the principles by which complex internal models (1) are represented in neural activities, (2) are adapted to the environment, (3) can be shown to be task-independent, and (4) generalise across very different response modalities.

The mentalistic roots of human communication

Julian Jara-Ettinger

Yale University, USA

Human commonsense psychology is structured around a basic assumption that agents act by quantifying, comparing, and maximizing their subjective utilities. In this talk I will present evidence that, by guiding how we interact with others, commonsense psychology also shapes our most basic forms of communication, including how we convey meaning through objects, gestures, and words.

I first show how a computational model of commonsense psychology spontaneously gives rise to simple non-linguistic communicative behaviors that are ubiquitous in human society. Next, I show how these models predict that abstract gestures (body movements that communicate messages such as “yes,” “I don’t know,” or “hello”) ought to be shaped to reveal that they have no object-directed goals. Specifically, our model predicts that rarity and repetition are key features of communicative gestures. Consistent with this, people from industrialized and non-industrialized societies (as represented by US and Tsimane’ participants) see rare and repetitive movements as communicative. Moreover, rarity and repetition are pervasive features in a dataset of over 250 abstract gestures from around the world. Finally, I show how models of referential communication centered on commonsense psychology diverge from, and systematically outperform, models of communication based on information theory. Together, this work suggests that computational models of commonsense psychology can help explain the origins and structure of simple everyday communication.

The emergence and developmental trajectory of ecological and active learning

Azzurra Ruggeri

Max Planck Institute for Human Development, Berlin, Germany

The internet has made information available at our fingertips at all times: Search engines, accessed via our computers, tablets, or smartphones, allow us to look up things whenever and wherever we want—an enhanced encyclopedia of factual knowledge. This pseudo-infinite space of immediately available knowledge has drastically reduced our need to learn and memorize facts. However, it has increased the urgency to know how to navigate this space effectively. This revolution, triggered by the era of globalization and digitalization, calls for a new science of learning, one that is more focused on how and what to learn—how to effectively ask questions and explore, *which sources of information to trust and rely on*, how to adapt one's learning strategies to dynamic and multimodal learning environments, *how to interpret* the information collected, integrating them in one's existing body of knowledge—rather than on standard learning contents. This talk presents the results of recent studies investigating theoretically and empirically the emergence of these abilities, their developmental trajectory across childhood and the factors impacting their success.

The irresistibility of sadness: towards the prediction of depression relapse after antidepressant discontinuation

Quentin Huys

Max Planck UCL Centre for Computational Psychiatry and Ageing Research, London, UK

Depression is common and an episode of depression can be devastating. However, depression is amongst the most burdensome disorders worldwide because it often takes a chronic relapsing-remitting course, with periods of health punctuated repeatedly by illness. Antidepressant medications are important in the treatment of depression, but those fortunate enough to respond often relapse after discontinuing. The mechanisms leading to relapse are as yet poorly understood, and hence the decision cannot be properly informed. Here, I will present first results from a longitudinal study examining neural and behavioural predictors of relapse after antidepressant discontinuation. Behaviourally, we find that patients with a remitted depression are averse to making decisions to invest effort, and take long to make these decisions. Computational modelling identified a prominent tendency to change their mind after deciding to invest effort, which contributes to the longer decision-times amongst those who go on to relapse. Strikingly, the discontinuation of antidepressants does not affect this, but rather the exertion of effort itself, suggesting that relapse after antidepressant discontinuation entails a complex process involving both vigour and evaluation. We also find that an EEG measure of emotional reactivity to sad mood indexes relapse risk. I will discuss these findings in the context of the cognitive and computational neurobiology of depression, and describe key next steps for the translation of these findings into the clinic.

The troubled mind: Some thoughts on how we solve problems -- and why we make them for ourselves

Laura Schulz

Massachusetts Institute of Technology, USA

Computational models of the mind have long tackled problems of inductive inference, considering how learners represent and distinguish competing hypotheses. Here I will present a few recent studies showing a precise, quantitative fit between children's exploratory behavior and the difficulty of discriminating competing hypotheses, suggesting that children represent their own ability to solve problems and calibrate their effort appropriately. I will also discuss how children's representation of the costs and rewards of actions might support their judgments of others' competence and motivation with implications for the ways they divide labor and allocate roles. I will end with some speculations on hypothesis generation and our propensity to create problems for ourselves.

Abstracts – Young researchers' talks

Toddlers are capable to anticipate the informativeness of their actions.

Marie Aguirre (Institute for Cognitive Sciences Marc Jeannerod UMR5304, Lyon, France)

Shelby Wicklacz (Institute for Cognitive Sciences Marc Jeannerod UMR5304, Lyon, France)

Anne Reboul (Institute for Cognitive Sciences Marc Jeannerod UMR5304, Lyon, France)

Olivier Mascaro (Institute for Cognitive Sciences Marc Jeannerod UMR5304, Lyon, France)

Humans have the ability to discover new behaviors to collect valuable data, for instance, by assessing the quality of evidence resulting from possible interventions in the world. This research project focuses on the developmental origins of this capacity in toddlers ($N = 104$), by testing their ability to anticipate an action's informativity. The participants had to find a character hidden in a box or among three distractors. By manipulating the experimental context (i.e., the characteristics of the box or distractors), we modified the potential informativity of the toddlers' actions. In Study 1, we manipulated whether the exact same action (opening a window) allowed to gain visual access to a target in order to locate it. In Studies 2 and 3, we manipulated whether flipping objects to gain visual access to symbols was relevant to identify a target. The results revealed that toddlers can adjust their behaviors to select the relevant source of data depending on the context. These studies suggest that toddlers anticipate the informativeness of their actions, a capacity that is crucial to support creative active learning and hypothesis testing.

Keywords: *informativity, search, development*

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Generalizing Functions in Sparse Domains

Pablo Leon Villagra (University of Edinburgh, United Kingdom)

Christopher G. Lucas (University of Edinburgh, United Kingdom)

People can learn relationships between continuous quantities and exhibit inductive biases, such as a tendency to infer linear relationships. This capacity, function learning, has been studied extensively, but research has tended to set aside the question of where our inductive biases come from, despite their essential role in our ability to generalize beyond our immediate experience. We propose that people, rather than relying on static, one-size-fits-all expectations, are able to quickly form abstract beliefs about the kinds of relationships that are plausible in a particular context, and can use those beliefs to generalize efficiently and accurately to new relationships. We tested this proposal in four experiments, by exposing participants to different examples of a particular abstract relationship, and found that this experience dramatically changed their inferences about a new relationship, and allowed them to accurately extrapolate from very sparse data. The use of past knowledge appears to go beyond remembering previous concrete evidence, and suggests that people are developing abstract beliefs and adapting them to make sense new data. Our results support the idea that human generalization rests on learning and inferring hierarchical representational structures over generative models of the world, allowing for efficient one-shot inference and generalization.

Keywords: *human generalization, function learning, transfer learning*

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Ten-month-olds do not expect agents to choose larger quantities of goal objects

Laura Schlingloff (Central European University, Budapest, Hungary)

Denis Tatone (Central European University, Budapest, Hungary)

Gergely Csibra (Central European University, Budapest, Hungary)

The naïve utility calculus theory of action understanding (Jara-Ettinger et al., 2016) argues that humans view goal-directed agents as utility-maximizers, who will behave in such a way that they minimize action costs and/or maximize rewards given relevant situational constraints. While a wealth of research supports that infants as young as 6 months of age expect agents to minimize costs, work on infants' understanding of reward maximization is lacking.

In the present study, we investigated whether 10-month-olds expect an agent to select an outcome of higher reward magnitude, operationalized in terms of larger resource quantity. Using a violation-of-expectation paradigm, we familiarized infants ($n = 24$) to an agent repeatedly approaching one of two different objects. At test, the agent approached either one over three tokens of the previously approached object (inconsistent trial) or three over one token (consistent trial). Contrary to our predictions, infants looked longer to the consistent test trial, suggesting that they expected the agent to pursue the same goal as in familiarization, rather than maximize his utility by selecting the higher-quantity reward.

Keywords: *infant social cognition, naïve utility calculus, action understanding*

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On the role of time in perceptual decision making

Ádám Koblinger (Central European University, Hungary)

David Zoltowski (Princeton University, US)

József Fiser (Central European University, Hungary)

Máté Lengyel (University of Cambridge, UK; Central European University, Hungary)

Stimulus-independent fluctuations in the responses of sensory neurons are traditionally considered as mere noise, and thus a source of perceptual ambiguity. In contrast, sampling-based models of perceptual inference suggest that the magnitude of this intrinsic variability acts as a signal: it conveys information about the uncertainty in low-level perceptual estimates. In both cases, to improve accuracy, downstream areas need to average sensory responses over time. However, due to the different roles that upstream sensory variability plays under the "noise" and "signal" hypotheses, the uncertainty about this average behaves in fundamentally different ways in them. In order to compare these hypotheses, we used a modified orientation estimation paradigm in which, on every trial, subjects simultaneously reported their best estimate of one of several briefly viewed, static line segments and their confidence about this estimate. Critically, while both models could account for changes in estimation performance with stimulus parameters, only the "signal" model predicted correctly the experimentally observed changes in confidence reports, and in the strength of correlation between confidence reports and actual accuracy. These results offer a new psychophysical window onto the role of sensory variability in perception and indicate that it conveys useful information about uncertainty.

Keywords: *perceptual inference, sensory noise, probabilistic sampling*

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Poster sessions

Poster Session I -- 10.00-11.30, 24 May (Friday)

I-01: Twelve-month-olds readily learn labels denoting sets and combine them with kind labels

Barbara Pomiechowska, Gábor Bródy, Ernő Téglás, Ágnes Melinda Kovács

I-02: Learning new contingencies by model revision

Danaja Rutar, Sabine Hunnius, Johan Kwisthout

I-03: Joint action planning: Minimizing the aggregate individual costs of co-actors

Georgina Török, Oana Stanciu, Natalie Sebanz, Gergely Csibra

I-04: The Strategy Aggregation Effect in Group Judgment

Henrik Olsson, Mirta Galesic

I-05: What representations drive retrieval-dependent eye-movements?

Johannes Mahr, Yul Kang, Krisztina Andrási, Márton G. Nagy, Máté Lengyel, Gergely Csibra

I-06: Human adults spontaneously represent giving, but not taking, actions as social interactions

Jun Yin, Denis Tatone, Gergely Csibra

I-07: Do we precisely monitor our own advice-taking behaviors?

Kitamura Miho, Sasaki Kyoshiro, Ishii Tatsunori, Watanabe Katsumi

I-08: Context sensitivity and norms: A pretense play study with preschoolers.

Krisztina Andrási, Ildikó Király

I-09: Are scale errors induced by associating functions to categories of objects in 3-year-old children?

Katalin Oláh, Ildikó Király

I-10: The Effect of Music on Implicit Motives

Leon Martin, Sophie Lentz

I-11: Infant Directed Speech affects face processing in 4-month-old infants

Louah Sirri, Szilvia Linnert, Vincent Reid, **Eugenio Parise**

I-12: Developmental continuity in perspective ability as an alternative to the implicit and explicit theory of mind controversy

Marta Białecka-Pikul, Arkadiusz Białek, Magdalena Kosno

I-13: Poor sleep quality predicts next days' psychotic-like experiences in a three-week prospective study

Noémi Báthori, Bertalan Polner, Tamás Nagy, Péter Simor

I-14: No forest through the trees? Investigating the role of cultural individualism-collectivism in a false memory creation

Patrycja Maciaszek

I-15: Do pre-schoolers use hypothetical common cause abduction when reasoning about correlated events?

Ramiro Glauer, Caroline Wronski

I-16: Prosody and syntax in encoding information structure in Russian: an experimental study

Sofiya Popova, Natalia Slioussar

I-17: A spatially and frequency-specific method for the analysis of sensorimotor power activity: focal vibratory intervention example.

Valentina Bulgakova, Nikolai Smetanin, Alexei Ossadtchi

Poster Session II -- 15:30-17:00, 24 May (Friday)

II-01: Face processing differences between dyslexics and neurotypicals

Adrienn Réka Oláh, Kornél Németh

II-02: Is young children's theory of mind performance related to their ability to flexibly update internal models?

Anna-Sophie Immel, Marlene Meyer, Mareike Altgassen, Sabine Hunnius

II-03: What happens on the screen stays on the screen: 19-month-olds do not interpret animations as real physical events

Barbu Revencu, Gergely Csibra

II-04: Adaptive memory distortions from generative compression

David G. Nagy, Balázs Török, Gergő Orbán

II-05: Correlated component analysis for measurement synchronization of cortical EEG signal during movie viewing

Egor Levchenko, Vasilii Klucharev

II-06: How do we remember implicit commitments?

Francesca Bonalumi, Johannes Mahr, Christophe Heintz

II-07: Investigating the role of fairness in task distribution

James Strachan, Georgina Török, Natalie Sebanz

II-08: Differences in response times across cultures while learning complex categories

Júlia Baross, Anett Ragó, Krisztián Borbély, Mátyás Varga

II-09: Children's Spatial Reasoning: Training Multiple Model Representation

Kevin Demiddele, Tom Heyman, Walter Schaeken

II-10: Bilingualism and second language learning effects on lexical access in the second language

Kristina Vujnović Malivuk, Marijan Palmović, Lovorka Zergollern-Miletić

II-11: Mental quantifier line?

Levente Madarász, Vjieran Kerić

II-12: Cognitive function in youth with early onset and at risk of schizophrenia: fMRI meta-analyses

Marie Arsalidou, Zachary Yapple, Tomas Jurcik, Vadim L. Ushakov

II-13: Decision making in reward tasks: Over-arching brain clusters in children, adolescents and adults

Zachary A. Yapple, Rongjun Yu, Marie Arsalidou

II-14: The pupillary response to highly familiar complex stimuli

Márton Nagy, Ildikó Király

II-15: Integrating cognitive processes and network structure to model belief dynamics in the real world

Mirta Galesic, Henrik Olsson, Daniel L. Stein

II-16: Investigating children's sense of exhaustivity in a search task with a rake-like tool

Paula Fischer, Ernő Téglás, Ágnes M. Kovács

II-17: Language affects pragmatic reasoning: The case of adjective interpretation

Paula Rubio-Fernández, Julian Jara-Ettinger

II-18: Music-based sleep therapy to improve sleep quality and cognitive functions in Williams syndrome

Szandra László, Magdolna Szabadi, Dániel Kőrössi, Ilona Kovács

II-19: The effects of novelty and expectations on human memory

Richárd Reichardt, Bertalan Polner, Péter Simor

II-20: Do Expertise Differences Exist in the Understanding of Visual Analogies?- An Eye-Tracking Study

Zsófia Miklós, Anett Ragó, Anikó Kónya

Poster Session III -- 10.00-11:30, 25 May (Saturday)

III-01: Do metaphors bring along their literal concrete meaning? A divided visual field ERP investigation of figurative expressions

Bálint Forgács, Alex Ilyés

III-02: Do individuals represent the costs and rewards of coordination when deciding to act together?

Arianna Curioni, Pavel Voinov, Gunther Knoblich

III-03: Frontal hemispheric lateralization as reflected by sleep EEG spindles: sex, sleep cycle and age effects

David Rottmayer, Dorina Ali, Róbert Bódizs

III-04: Kindergarteners' Active Use of Category Knowledge

Eszter Dóra Szabó, Anett Ragó

III-05: Modeling executive functions in the prefrontal cortex

Frédéric Alexandre

III-06: The effect of referential uncertainty on encoding novel words

Hanna Marno, Bojana Traković, Robert Danyi, Dan Sperber

III-07: Studying the temporal dynamics of analogy-making in children and adults with eyetracking data: scanpath-comparisons, machine-learning classification algorithms and data predictability

Jean-Pierre Thibaut, Robert French

III-08: Changes in mechanisms of implicit, complex visual image categorization during aging

Krisztián Borbély, Anett Ragó

III-09: EEG Classifications: The Warping Window Size Does Not Matter That Much

Krisztián Buza, Tomáš Horváth

III-10: Privileged Access: What Do We Know about Bilinguals?

Krisztina Bartha

III-11: Brain activity and hemispheric dominance in response to increasing complexity of mathematical calculations

Ksenia Konopkina, Marie Arsalidou

III-12: Test-retest reliability of canonical reinforcement learning paradigms

Laura Weidinger, Andrea Gradassi, Lucas Molleman, Wouter van den Bos

III-13: Same Words, Same Context, Different Meanings: People are unaware that their own concepts are not always shared

Louis Marti, Steven Piantadosi, Celeste Kidd

III-14: Ways of thinking about time and coping with negative affect

Małgorzata Sobol-Kwapińska, Aneta Przepiórka

III-15: ‘I don’t know but I know who to ask’: 12-month-olds actively seek information from knowledgeable adults

Marina Bazhydai, Gert Westermann, Eugenio Parise

III-16: The fine structure of eye movements reveals predictive internal models of dyadic agent dynamics in 14-month-old infants

Merse E. Gáspár, Jun Yin, Gergely Csibra, Máté Lengyel

III-17: Active Learning Across a Sequence of Tasks: Adapting to Change

Nicolas Collignon, Christopher Lucas

III-18: Preschoolers’ Metaphor Comprehension in Causal Contexts

Rebecca Zhu, Mariel Goddu, Alison Gopnik

III-19: Examining the relationship between the comparison distance effect and the priming distance effect in numerical cognition

Tamás Szűcs, Attila Krajcsi

III-20: Depression, Social anxiety and Coping Strategies - empirical study of congenital prosopagnosia

Zsófia Varga, Kornél Németh

Abstracts – Posters

Poster Session I -- 10.00-11.30, 24 May (Friday)

I-01: Twelve-month-olds readily learn labels denoting sets and combine them with kind labels

Barbara Pomiechowska (Central European University)

Gábor Bródy (Central European University)

Ernő Téglás (Central European University)

Ágnes Melinda Kovács (Central European University)

The meaning of complex expressions (e.g., “two apples”) is derived from the meaning of its constituents (e.g., “two”, “apples”). Here, we investigated whether preverbal infants compute the meaning of complex noun phrases by combining familiar common nouns and newly learnt quantity labels.

Experiment 1 demonstrated that 12-month-olds (N= 20) learnt two distinct labels denoting a singleton and a pair. At training, infants saw scenes depicting the target concepts: e.g., 1 duck in one location; 2 ducks in another location. Both referents were subsequently named with one pseudo-word for the singleton (e.g., “moxi duck”) and one for the pair (e.g., “dax duck”). At test, infants looked longer at the referent representing the named quantity.

Experiments 2-3 demonstrated that infants combined the meaning of the quantity labels with the meaning of kind labels. When presented with four potential referents (e.g., 1 duck, 2 ducks, 1 ball, 2 balls), infants oriented to the target satisfying the meaning of both labels (e.g., one ball) over the distractors satisfying the meaning of the labels separately (e.g., two balls, one car).

This suggests that 12-month-olds have access to conceptual structures that contribute to learning of the numerals and are used in complex linguistic computations.

Keywords: *word learning, number cognition, compositionality*

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I-02: Learning new contingencies by model revision

Danaja Rutar (Donders Institute for Brain, Cognition and Behaviour, The Netherlands)

Sabine Hunnius (Donders Institute for Brain, Cognition and Behaviour, The Netherlands)

Johan Kwisthout (Donders Institute for Brain, Cognition and Behaviour, The Netherlands)

Within predictive processing, learning is formalized as model updating during which models are modified through changing prior expectations based on new observations – structure of the model not changed. However, we suggest that when novel statistical regularities are encountered, a different learning mechanism is employed – model revision. The latter refers to adding/removing variables and causal connections to/from the model thus structurally rewiring it. We examined model updating and revision in a computer-based experiment where participants had to predict the location of a target based on cues and a tone. Participants' prediction errors (PE) were measured through assessing their pupil dilation (PD). In the updating condition participants learn that cues are predictive of the target location and tone is not. Here, we expect PD to steadily decrease and decreases to become smaller over time, as participants will learn the regularity and sensory evidence will gradually generate less error. In the revision condition participants need to learn that tone becomes predictive of the target location. Upon realizing this change in the previous rule, participants revise their model thus rapidly decreasing PE and consequently PD. We are currently finishing data analysis, results of the study will be presented at the conference.

Keywords: *model revision, model updating, prediction error, pupil dilation*

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I-03: Joint action planning: Minimizing the aggregate individual costs of co-actors

Georgina Török (Central European University)

Oana Stanciu (Central European University)

Natalie Sebanz (Central European University)

Gergely Csibra (Central European University)

In joint actions, co-actors share not only their goals but also the costs of the actions necessary for goal achievement. How do they distribute these costs among each other, given the constraints of coordination? Previous studies suggest that, at least in repeated interactions, cooperative agents make decisions that minimize the aggregate, rather than the individual, costs of sequential joint actions. The present study tested the hypothesis that co-actors decide on a course of action based on the summation of separately assessed individual costs of the co-actors. The study adopted a touchscreen-based joint object matching task. Participants were instructed to collect one matching object pair in each trial in a speeded manner. The distances of each target object from the actors were manipulated, allowing us to estimate the Self, Other and Joint costs for each dyad. We analyzed the relationship between the different cost parameters and participants' decisions. Our results suggest that co-actors generally prioritize joint cost minimization over individual (Self or Other) cost minimization, even when they can only calculate joint costs by adding up individual costs that need to be computed separately. This finding supports the idea that people plan joint actions with the group's effort in mind.

Keywords: *joint action, planning, decision-making, rationality, coordination*

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I-04: The Strategy Aggregation Effect in Group Judgment

Henrik Olsson, Santa Fe Institute, USA

Mirta Galesic, Santa Fe Institute, USA

What characteristics of cognitive strategies affect the predictive accuracy of individual and group judgments? We relate the literature on model performance in statistics and machine learning to performance of realistic cognitive strategies in individual and group settings. We investigate two well-studied classes of cognitive strategies: unconstrained and constrained linear judgment strategies. We show that constrained strategies are more accurate for individual judgments, but when individual judgments are aggregated to produce a group judgment an unconstrained strategy is more accurate. This strategy aggregation effect can be understood by analyzing a decomposition of the mean squared error into bias, variance, and covariance. Because of their lower bias but higher variance, unconstrained strategies perform worse for individual judgments, but better for group judgments where aggregation minimizes variance. In computer simulations with artificially constructed and real environments, we further show that this aggregation effect does not occur if there are correlations between individual judgments. Here, constrained strategies always outperform an unconstrained strategy, because the larger covariance component of the unconstrained strategy outweighs its lower bias.

Keywords: *judgment, wisdom of crowds, constrained linear models*

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I-05: What representations drive retrieval-dependent eye-movements?

Johannes Mahr (Department of Cognitive Science, Central European University)

Yul Kang (Computational and Biological Learning Lab, University of Cambridge)

Krisztina Andrási (Department of Cognitive Psychology, Eötvös Loránd University)

Márton G. Nagy (Department of Cognitive Science, Central European University)

Máté Lengyel (Computational and Biological Learning Lab, University of Cambridge;
Department of Cognitive Science, Central European University)

Gergely Csibra (Department of Cognitive Science, Central European University)

It is well known that episodic memory retrieval involves ‘retrieval-dependent’ eye movements. There is, however, debate about what kind of memory representations drive these eye movements. Here we present a study investigating the richness of the information expressed in retrieval-dependent eye movements in a location memory task. Participants were presented with a series of object-location pairs on a circular array and were asked to encode the location of each object for a later memory test. Next, participants were presented with (new and old) object-location pairs allegedly produced by another participant in the upcoming memory test and were asked to judge the correctness of each of these pairs in light of the first encoding phase. Finally, participants were asked to remember the location of each object themselves. We analyzed eye-movements in a 2,5 seconds pre-response time window in the final memory test in order to determine how much information about the history of each object-location pairing can be recovered from retrieval-dependent eye-movements alone irrespective of explicit responses in the memory test. We will present the preliminary results of this analysis as well as possible implications for our understanding of episodic memory retrieval mechanisms and their expression in eye movements.

Keywords: *episodic memory, retrieval-dependent eye movements, location memory, misinformation*

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I-06: Human adults spontaneously represent giving, but not taking, actions as social interactions

Jun Yin (Ningbo University, China)

Denis Tatone (Central European University, Budapest)

Gergely Csibra (Central European University, Budapest)

In linguistics, the verb ‘give’ is an obligatorily three-place predicate, requiring distinct arguments for agent, patient, and object. This is not the case for ‘take’, whose meaning is preserved even the patient is omitted. Such an asymmetry is also evident in the infants’ action schemas, which include the patient for giving, but not for taking, events. The present study tested whether adults similarly exhibit an asymmetric encoding of patients in giving and taking events using nonlinguistic stimuli.

In a change-detection paradigm, after seeing an agent carrying an apple towards an animate or inanimate patient (giving vs. disposing), or away from these (taking vs. acquiring), participants were presented with three test conditions: no change, new patient (NP), within-pair role reversal (RR). Sensitivity to RR changes was higher than to NP changes for taking, acquiring, and disposing. In contrast, sensitivity to NP was higher than to RR changes in giving: only for giving proper participants were more likely to confuse the roles of agents and patients and to detect new agent-patient pairings. This suggests that, even when linguistic descriptions are not required, the perception of giving actions spontaneously calls for the inclusion of patients in the event representation.

Keywords: *social cognition, action schemas, interactions, change detection*

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I-07: Do we precisely monitor our own advice-taking behaviors?

Kitamura Miho (Waseda University)

Sasaki Kyoshiro (Waseda University)

Ishii Tatsunori (Waseda University)

Watanabe Katsumi (Waseda University; University of New South Wales)

People often take other people's advice when making real-life decisions. While studies have examined the cognitive processes of advice-taking, it is less studied how people evaluate advices and monitor their own advice-taking (i.e., acceptance or rejection). We explored those by using a price estimation task. In each trial, participants estimated the price of a chair on the basis of its appearance. Then, another estimation made by a person who worked for the furniture store was given as advice. Participants made the final decision by accepting fully or rejecting it. The actual price of the chair was notified at the end. After completing the total of 46 trials, participants were asked two questions: (1) How useful did they felt the advice? And, (2) what percentage of the trials did they accepted the advice for? The results showed that the participants felt the advice useful. Interestingly, we found that the participants exaggerated their acceptance or rejection rates; the participants who accepted more (less) tended to think they accepted even more (even less). Our results suggest that people do not precisely monitor or track their own advice-taking behaviors.

Keywords: *advice taking, decision making, metacognition*

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I-08: Context sensitivity and norms: A pretense play study with preschoolers.

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Understanding the appropriate context within which social norms are applicable is a great challenge for children during development, as the scope of applicability of these norms may vary from situation to situation (Kalish & Sabbagh, 2007). In our study, we aim to explore whether children around the age of 3 and a half consider if someone witnessed the stipulation of a game rule when calibrating its scope of applicability. During the experiments, children play together with an experimenter and well-known objects. Two pretense play episodes are connected to each object: the first corresponds to the original function of the object with a given prop, and the second is made up on the scene with another prop. This happens in either the presence or the absence of a second experimenter. Following these episodes, the second experimenter decides to play with the object, and asks for a ‘missing’ prop. We plan to measure how children interpret this request by recording their object giving choices. The data collection is still ongoing, but we predict that children would choose the object corresponding to the pretense function when the experimenter was present during the play episode, but give the other prop in case she was absent.

Keywords: *social cognition, pretend play, theory of mind*

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I-09: Are scale errors induced by associating functions to categories of objects in 3-year-old children?

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It has been suggested that children's proneness to commit scale errors may originate from their propensity to reason about artefacts as existing to fulfil a specific function. In this view, children overlook size information because they focus on the function with which the given tool category is associated. However, so far, it has not been directly tested whether categorisation indeed plays a part in the occurrence of scale errors. In this study, 3-year-old children were presented with object sets consisting of a target and a potential tool to bring about a certain goal. First, a model demonstrated the object functions. After this, children were handed the object sets for exploration, however, the sets contained an important alteration. In the experimental condition, the original tool was replaced by one that only differed in two characteristics from the original one: it was differently coloured and was too big to efficiently bring about the goal. In the control condition, the tool was the same colour but was oversized. Children were also provided with a novel, affordant tool. Data collection is ongoing, however, preliminary results show that children commit scale errors in both condition to a similar degree.

Keywords: *scale error, function, categorisation, social learning*

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I-10: The Effect of Music on Implicit Motives

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In an exploratory study we investigated the effect of music on motivation. Measures of the implicit need for power (nPow), affiliation (nAff) and achievement (nAch) as well as activity inhibition (AI) were considered. Two non-vocal, classical compositions with different emotional tone were played whereas subjects were asked to write a picture story exercise (Schultheiss & Pang, 2007) to assess the motive imagery. Those values were then compared within-subject to a non-acoustic baseline PSE, and between-subject to a non-musical control condition (noise). We tested whether a powerful, assertive music could arouse nPower and suppress nAffiliation or whether sweet and romantic music could elicit the inverse effect. Additionally, a substantial effect on AI was considered. Sixty subjects were assigned in a block randomized style to one of the three acoustic conditions. Results showed that powerful, assertive music arouses more nPow compared to sweet, romantic music, which induced more nAff respectively, both with medium effect sizes. With regard to nAch and AI no effects were shown. However, further research is advantageous in regard to the clear tendencies towards our hypotheses.

Keywords: *motivation, music, implicit motives*

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I-11: Infant Directed Speech affects face processing in 4-month-old infants

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Newborns and infants prefer faces with direct gaze over faces with averted gaze (Farroni, Csibra, Simion, & Johnson, 2002), and also show an enhanced N290 ERP component to them. One possibility is that direct gaze is an important source of information (Gliga & Csibra, 2007), suggesting that infants are specifically sensitive to communicative signal. (Csibra, 2010). In two ERP experiments we studied whether a different communicative signal, infant-directed speech (IDS), could also enhance face processing in 4-month-olds. In Experiment 1 infants heard a word, uttered either in IDS or adult-direct speech (ADS), followed by an upright face. In Experiment 2 faces were presented upside down. Only upright faces produced a N290 effect depending on the preceding speech, with faces preceded by IDS eliciting a larger N290 component. Such effect was not present with upside down faces. Instead we found a Nc effect, with a larger Nc component for upside down faces preceded by IDS compared to the same stimuli preceded by ADS. These results show that for 4-month-old infants, IDS has a specific effect on face processing, enhancing the early stages of face perception, rather than merely increasing attention to them.

Keywords: *infants, face processing, IDS, ERP, N170*

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I-12: Developmental continuity in perspective ability as an alternative to the implicit and explicit theory of mind controversy

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The question ‘what is the relation between explicit theory of mind and implicit theory of mind?’ should be reconsidered from developmental and social-interactional perspectives (Carpendale, Lewis, & Müller, 2018; Moll & Meltzoff, 2011). We propose a model of continuous development of perspective ability which consists of 8 different sub-abilities emerging in a sequence from joint attention, i.e., social perspective tracking ability to explicit theory of mind, i.e., epistemic perspective taking ability. Twenty-five different tasks were used to test our model in a longitudinal 6-wave study with 300 children aged from one year to three-and-a-half years. Structural equation modeling with factor scores for each of the eight sub-abilities of perspective ability was used. Our results confirmed the developmental continuity: from social perspective tracking at age one to epistemic perspective taking at age three and a half (RMSEA = 0.052; CFI = 0.926; TLI = 0.80; SRMR = 0.034). We provided preliminary proof that six sub-abilities are clearly distinguishable in the observed developmental sequence: 1) social (copresence) perspective tracking and taking, 2) visual perspective tracking and taking as the intermediate step, and 3) epistemic perspective tracking and taking. The results are discussed with regard to social-interactional approaches in theory of mind research.

Keywords: *theory of mind, perspective tracking, perspective taking*

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I-13: Poor sleep quality predicts next days' psychotic-like experiences in a three-week prospective study

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Numerous studies suggest that poor sleep quality is associated and may contribute to psychotic-like experiences (PLEs). Sleep dysfunction is present in many psychopathological conditions (anxiety, depression, PTSD, schizophrenia) that also increase the risk of PLEs.

Poor sleep quality was consistently associated with PLEs in cross-section studies; however, only few studies examined the day-to-day covariation of sleep quality, daytime affective states and PLEs by prospective assessments. In our three-week long study we measured the day-to-day links between subjective sleep quality and daytime PLEs in a sample of healthy university students with medium to high trait schizotypy.

The temporal association between sleep quality and daytime PLEs, as well as the mediating role of mood was examined by multilevel regression models. Furthermore, we investigated the bidirectional links between these variables. Our findings indicate that poor sleep quality predicts worse mood and higher PLEs during the following day, but not vice versa, that is, higher PLEs during the day did not significantly predict sleep parameters the following night. Our findings suggest that improving the quality of sleep may attenuate daytime PLEs.

Keywords: *sleep, psychotic-like experience, schizotypy, mood, experience sampling*

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I-14: No forest through the trees? Investigating the role of cultural individualism-collectivism in a false memory creation

Patrycja Maciaszek (Jagiellonian University, Poland)

Remembering, as comprehensive and multicomponent process remains prone to undergo various distortions. Current paper aims to investigate the impact of cultural variables on individuals' tendency to create specific memory distortions, namely false memories.

To reach this goal, studies focused on cultural differences in memory content were conducted, with the principal interest on national collectivism – individualism level, as the factor believed to affect memory in the same way it affects other cognitive processes.

It was hypothesized to observe salient impact of C-I, as well as FDI (field-dependence/independence) in false memory studies.

Previous studies were focused mainly on internal factors influencing participants' memory, such as individual cognitive efficiency (pointing at the importance of working memory and attention) or current state of mind (reflective vs impulsive). External, socio-cultural factors (ie. suggestion effect) however examined briefly, also turn out to be important. Shining more light on environmental bases of FM was the aim of current study.

In order, results achieved by participants from China, Poland, Turkey, and US in classical procedure to assess FM effect (DRM lists-of-related- words) were compared. Pattern of obtained results allow to confirm previous supposition: individuals' preferences of field-dependence/independence turned out to be important factor to predict FMs occurrence, as well as pre-established level of national collectivism-individualism.

Keywords: *false memory, DRM, collectivism, individualism, reflectiveness*

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I-15: Do pre-schoolers use hypothetical common cause abduction when reasoning about correlated events?

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Caroline Wronski (University of Applied Sciences Potsdam, Germany)

Children are often described as „little scientists“, mainly on the basis of ample evidence for their early probabilistic and causal reasoning skills. Recent research has demonstrated that children rely not only on probabilistic information but on explanatory virtues, such as simplicity, when reasoning about events. These studies demonstrate that children select explanations in a way that could be described as factual-cause abductions. However, a hallmark of scientific reasoning is not only the selection of factual cause explanations but the generation of new hypotheses, in particular, hypothetical common causes. According to Reichenbach’s principle, a hypothetical common cause can be inferred if we encounter several intercorrelated phenomena and can exclude that they are caused by each other. Such a unification of phenomena is one of the major aims of scientific enquiry. In the planned study, children will be presented with two events (physical or biological) that are probabilistically dependent but not causing each other and then prompted to choose among explanations that (A) account for each of the events separately or (B) provide a hypothetical common cause explanation. If children do reason like “little Einsteins”, they should prefer hypothetical common cause explanations over separate explanations for their greater unificatory power.

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I-16: Prosody and syntax in encoding information structure in Russian: an experimental study

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In different languages information structure (IS) is encoded differently: prosodically, with the use of specialized morphemes or syntactically. In Russian syntactic and prosodic encoding is used, the goal of our research is to find out how these means of encoding coexist.

Production. We compiled four texts in Russian with dialogues where the question implicates a specific IS in the answer. Answers are missing and participants are asked to fill the gap using given words in brackets. They are thus forced to encode a specific IS.

Comprehension. First, we cut out questions and answers read by native speakers and made 24 question-answer pairs. In half of the pairs, the question and the answer are taken from the same dialogue. In the other half, questions and answers are taken from different dialogues, which presupposed different IS. Participants are asked to rate whether they sound naturally or not (1 to 5 scale). Second, we cut out target sentences and asked the participants to listen to them and come up with questions to which these sentences could be used as answers.

Preliminary results show that participants always encode IS prosodically and sometimes syntactically and they successfully decode IS encoded syntactically and prosodically.

Keywords: *information structure, prosody, syntax*

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I-17: A spatially and frequency-specific method for the analysis of sensorimotor power activity: focal vibratory intervention example.

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Sensorimotor rhythms (SMRs) are 8-30 Hz oscillations in the electroencephalogram (EEG) that are modulated by sensorimotor activity and imagery. The peak amplitudes of the alpha (8-15 Hz) and beta (15-30Hz) SMRs and their spatial distributions vary for subjects, however the common approach in the field does not consider these individual differences. We developed a method for analyzing the sensorimotor activity based on spatial and frequency filtering, allowing us to extract individual components of the EEG activity and individual alpha and beta bands for each subject. We applied this method to evaluate the EEG effects of focal vibration delivered for one minute to the right hand of 10 healthy subjects. We hypothesized that vibration would cause contralateral event-related desynchronization (ERD), followed by event-related synchronization (ERS) after the end of vibration. ANOVA showed significant ERD in alpha ($p < 0.05$, $\eta^2 = 0.55$) and beta ($p < 0.05$, $\eta^2 = 0.30$) individual frequency bands distributed contralaterally during vibration and significant bilateral ERS in the beta ($p < 0.05$, $\eta^2 = 0.14$) band following vibration, showing the feasibility of the method and providing intriguing insight into distinct functions of the beta and alpha SMR. The method can be applied for the analysis of subject sensorimotor activity and BCI control based on motor imagery.

Keywords: *sensorimotor rhythms, focal vibration, EEG analysis*

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Poster Session II -- 15.30-17.00, 24 May (Friday)

II-01: Face processing differences between dyslexics and neurotypicals

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Current results suggest a domain-general, high level visual deficit in developmental dyslexia, which effect also the face processing abilities.

In line with these results, we hypothesized that face processing effectivity of people with dyslexia is decreased when compared to controls.

Methods: The memory component of face processing was assessed by the Cambridge Face Memory Test (CFMT), while the perceptual component was measured using the Cambridge Face Perception Test (CFPT). We also used the faceparts-matching test, which was designed to estimate in details the perceptual effectivity of face part recognition. The test measures the processing ability of the chin, ears, nose, lips, and eyes.

The experimental group consisted of people with developmental dyslexia (17.12 ± 1.36 years; N=48). The mean age of the control group was 30.80 ± 12.49; N=91).

The results show that both the perceptual and the memory components of face processing are decreased at the group level, with great individual differences. The faceparts-matching test revealed that recognition of face components is significantly impaired when compares to controls but not for all face parts.

The behavioral deficits revealed by our studies urge further studies examining the neural correlates (i.e. the nature of face-processing related N170 component) of face processing in dyslexia.

Keywords: *developmental dyslexia, face processing, face-part recognition, face memory*

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II-02: Is young children's theory of mind performance related to their ability to flexibly update internal models?

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Mareike Altgassen, Donders Institute, Radboud University, Nijmegen, The Netherlands

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Passing the classical false belief task is regarded as the litmus test for having a theory of mind (ToM). Using a Bayesian framework, Asakura and Inui (2016) argue that mastering a false belief task requires the fundamental ability to hold two models about the same situation in mind (one for oneself and one for another person) and to update them independently from each other. We dubbed this competence “differential updating”. In this study, we set out to investigate empirically whether young children's ability to update predictive models differentially is related to their ToM performance. In order to measure children's ability to update differentially we developed an eye-tracking paradigm in which children learn two similar predictive models (consisting of cue-target associations), followed by an update of one of the learned models but not of the other one. Children are assumed to be able to update differentially when letting the updating of one of the models not influence their previously learned prediction for the other (not updated) one. We expect that children who pass the differential updating task will also pass the classical false belief task.

Study design, hypotheses, and preliminary results will be presented.

Keywords: *theory of mind, model updating*

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II-03: What happens on the screen stays on the screen: 19-month-olds do not interpret animations as real physical events

Barbu Revencu (Central European University, Budapest, Hungary)

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Fictional entities such as animations and puppet shows are widely used in infancy research, and there is plenty of evidence suggesting that infants are able to make inferences based on them (e.g., ascribing agency to self-propelled 2-D figures). Little is known, however, about what infants make of these stimuli once they start interpreting them. In the present research, we ask whether 19-month-olds take what they see on the screen to be happening in the here and now, or whether they know that on-screen events are spatiotemporally decoupled from the immediate environment. We show that infants do not expect an animated ball falling on a screen to end up in real boxes below the screen. Two control experiments make sure that infants can track the location of the ball (i) when the falling ball is real; and (ii) when the boxes are also part of the animation. These findings cast doubt on the tacit assumption that infants are naïve realists and open up several questions about the ways in which infants encode information they do not take as physically real.

Keywords: *cognitive development, infant cognition, animated stimuli, fiction*

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II-04: Adaptive memory distortions from generative compression

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It has long been known that human memory is far from a carbon copy of sensory experience. Rather than being random noise however, the distortions in recalled experience show robust and systematic biases. Such systematic biases are often thought to reflect rational adaptations to computational resource constraints. We argue that these limitations can be formalised in the normative framework of lossy compression and that optimal adaptation to the constraints can be achieved by exploiting a generative model of the environment for compression. Recent advances in machine learning yielded powerful tools to approximate such solutions. In this study, we harness these advances to show that generative compression can explain a wide variety of memory phenomena including the effects of domain expertise on recall, gist based distortions in recalling lists of semantically related words and the influence of contextual cues in memory for hand drawn sketches.

Keywords: *episodic memory, memory distortions*

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II-05: Correlated component analysis for measurement synchronization of cortical EEG signal during movie viewing

Egor Levchenko (Higher School of Economics, Russia)

Vasiliy Klucharev (Higher School of Economics, Russia)

Our research describes the method to estimate the influence of film on brain activity. We think correlated component analysis (CCA) can be a good measure of audience engagement. CCA is a method which finds a spatial filter such that resulting components are maximally correlated. The final correlation can be defined as inter-subject correlation (ISC) which can be interpreted as how well the EEG of several subjects are similar and predictable. We hypothesized that engaging movies modulate high ISC values of brain activity compared to boring and ‘lost meaning’ movies. We record EEG from 38 healthy subjects during movie viewing. Each subject watched five 6-min movies in random order with 2 minutes break between. Three movies were chosen to modulate high engagement and for control, we use scrambled in time movie (‘lost meaning’) and a movie with an open view of an ocean. As a result, we obtain high ISC values for three engaging movies and low ISC for a boring movie, but, surprisingly, the scrambled movie shows a lot of significant correlations. It shows the limitations of this method and sensitivity to abrupt changes in a movie.

Keywords: *electroencephalography, engagement, attention, inter-subject correlation*

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II-06: How do we remember implicit commitments?

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There is some evidence that people are more likely to recall the pragmatic implication of a sentence rather than the sentence itself (Brewer, 1977; Harris, 1974), suggesting that long-term memory processes influence sentence recall. We investigate whether, in communicative contexts, the recognition of speaker's meaning, i.e. 'what is meant' by the speaker, has an influence on how people recall utterances. We hypothesise the following: (1) memory is highly sensitive to speaker's meaning: the later the utterance is recalled, the more likely it will be re-constructed according to 'what is meant'; (2) the relevance of the implication has an effect on utterance recall: the utterance will be re-constructed on the basis of what the speaker implicitly committed to, and speakers will be held accountable on the basis of such recall.

To investigate this, we ran two studies in which participants were asked to read hypothetical scenarios that involve verbal interactions between two agents. Critically, the relevant content was never explicitly uttered by the speaker, but was only implied. Participants were then asked to recall the exact sentence uttered by the speaker.

Preliminary data support our first hypothesis, showing that the recognition of speaker's meaning influences the event recall and suggesting that people might re-construct implicit commitments as explicitly performed for accountability purposes.

Keywords: *commitment, episodic memory, implicit communication, pragmatics*

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II-07: Investigating the role of fairness in task distribution

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Individuals have a drive towards maximising action efficiency - given a choice of two actions to achieve the same goal, they will choose the action that incurs fewest costs. In joint actions, actors prioritise joint efficiency or co-efficiency, maximising the utility of the joint action even if this comes at a cost to themselves. However, when acting jointly it may also be important to consider factors other than efficiency, such as fairness. We investigate whether the reputational motivation to be seen as fair will interfere with participants' drive to maximise co-efficiency. We present the results of two experiments where participants complete the first part of a two-step joint action with a partner and have to decide between a fair action that requires equal contribution from both agents, and an unfair action that disadvantages either themselves or their partner. Participants consistently and reliably act in a way that maximises co-efficiency regardless of fairness or the costs that they incur individually, but they also take longer to perform actions that are unfair to their partner (rather than themselves). This suggests that although participants are sensitive to (un)fairness in task distribution they do not let this affect their decisions.

Keywords: *joint action, efficiency, fairness*

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II-08: Differences in response times across cultures while learning complex categories

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In the current research, we investigated how learning complex categories is mediated by implicit and explicit processes across East-Asian and European cultures. Based on previous results, culture accounts for differences on explicit classification-, and implicit sequence learning tasks. Furthermore, East-Asian participants are shown to integrate information on multiple stimulus dimensions, and focal and background information in a more efficient manner than North-American participants. In the present study, an information-integration paradigm was used, where the assignment of instances to the correct category can be achieved by relying on an explicit rule during the learning phase, while an implicit rule can also be acquired unconsciously. Thus, it is questioned whether implicit learning is affected differently by explicit cues across cultures, and whether differences emerge in reaction times when participants are urged to make fast, explicit decisions about complex categories, tapping on the implicit system, as well. Based on preliminary results, Korean and Chinese participants had faster reaction times while acquiring the same rate of learning as Hungarians, no matter whether explicit cues were present or not during the learning phase, while explicit cues slowed the response times of Hungarian participants.

Keywords: *implicit learning, explicit learning, culture, category learning*

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II-09: Children's Spatial Reasoning: Training Multiple Model Representation

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When reasoning with simple transitive relations (such as 'is left of'), children are known to have difficulties representing multiple possibilities. In this pre-registered study, we examine the effect of two training strategies on the reasoning performance of 204 11-year-olds. The reasoning tasks consisted of premisses on the relative position of objects (e.g. 'the book is left of the pen') on the basis of which they had to choose a correct conclusion on the spatial relation that was not explicitly described in the premisses. When they finished half of the tasks, we provided them a brief training session, based on mental model building strategies. We taught them how to represent multiple possibilities, either by representing multiple models or by representing isomeric models, i.e. single models that can represent uncertainty. There was a strong effect of training, especially on the targeted problem type of multiple-model problems with no valid conclusion. The participants in the isomeric training condition scored slightly better than those in the multiple-model condition and the isomeric notation proved more intuitive. Based on these results, we question the default way of characterizing multiple mental models in the literature.

Keywords: *mental models, spatial reasoning, cognitive development*

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II-10: Bilingualism and second language learning effects on lexical access in the second language

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The aim of this study is to explain why bilingual speakers perform worse than monolingual speakers in lexical access and language production tasks. There are two possible explanations, the executive functions approach and the "weaker links" approach. The executive functions approach explains their performance in terms of strong activation of both bilinguals' languages and the need to monitor and control both languages and the "weaker links" approach suggests that the worse performance can be explained by lesser exposure to each of the languages of a bilingual speaker.

The subjects in this study, early Croatian German bilinguals, Croatian students of German and non-proficient Croatian learners of German (differing in age of acquisition, automaticity and proficiency) were given two tasks that activated the executive control: a verbal and a non-verbal task. The two approaches yield different predictions: within the executive functions approach a difference in non-verbal task is expected between the groups, while the "weaker links" approach does not warrant such a prediction.

The results confirmed that bilingual speakers need higher amount of executive control for the verbal task, which activates both their languages, but the non-verbal task did not show any differences between the groups.

Keywords: *bilingualism, SLA, lexical access, automaticity*

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II-11: Mental quantifier line?

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Reliance on quantifiers is often noted in the reasoning literature for their potential in reducing information complexity or serving as input for truth preserving transformations. An often overlooked, but functionally just as important contribution of these representations is that they allow communication about quantities. An important question, previously only addressed in an indirect manner pertains to the type of numeric representations serving as input for the deployment of quantifiers (cf. Halberda, 2008 where noncounters fail at assessing proportional quantification if the cardinality of contrasted sets does not surpass the age-specific ANS discrimination threshold, and Pezzelle et al. 2018 suggesting an ordering of quantifiers on the basis of the quantified magnitude). Previous research suggests that numbers are represented spatially along a Mental Number Line (MLN) with increasing magnitudes from left to right. A strong argument for this claim comes from the SNARC-effect; facilitation of responses when magnitude matches the spatial location of the required response. In the submitted study, we are aiming to establish whether quantifiers trigger a SNARC-effect, which would be indicative regarding the representation family serving as their input.

Keywords: *quantifiers, numerical cognition, SNARC effect*

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II-12: Cognitive function in youth with early onset and at risk of schizophrenia: fMRI meta-analyses

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Relatives of patients with schizophrenia have a strong genetic disposition to develop schizotypal disorders, which express during adolescence or later. Deficits in cognitive function are a major characteristic of the disorder. Many functional magnetic resonance imaging (fMRI) studies examine brain correlates of cognitive function in adults with schizophrenia, showing altered prefrontal and temporal brain activity. fMRI studies also examine brain representation of cognitive function in adolescents with early onset schizophrenia and those at risk of the disorder, yet results are often inconsistent. We compile data from 16 eligible fMRI studies, and using quantitative meta-analyses, we reveal concordant brain activity associated with adolescent relatives of patients with schizophrenia and those with adolescent onset schizophrenia. We reveal similar functional hubs of brain activity (e.g., precuneus) yet in opposite hemispheres and no reliable clusters in prefrontal cortices. Other areas of altered implication include the middle temporal gyrus, insula and cerebellum. We discuss findings in reference to the protracted maturation of the prefrontal cortex and possible effects due to medication status of the two groups.

This study was partially supported by ofi-m RFBR grant 17-29-02518 (the cognitive-effective structures of the human brain).

Keywords: *cognitive function, schizophrenia, fMRI, meta-analyses*

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II-13: Decision making in reward tasks: Over-arching brain clusters in children, adolescents and adults

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Reward processing encompasses a broad range of psychological phenomena including feedback learning, delay discounting, reward reception and anticipation. Many functional magnetic resonance imaging (fMRI) articles have identified brain regions associated with reward processing in adults, that including the ventral striatum, orbitalfrontal cingulate and insular cortices. Critically, we know from behavioural data that children and adolescents process decision making related to rewards differently than adults. To better understand reward processing across development, we used quantitative fMRI meta-analyses to examine data from a total of 137 fMRI studies that investigated brain responses to decision making to reward tasks children (6-13 years), adolescents (13-18 years), and young adults (18-35 years). We find common clusters in striatal brain regions for all age groups. Adolescents show increased implication of dorsolateral prefrontal cortices, whereas adults show concordance and anterior and posterior midline cingulate cortices. We propose topographical atlases based on stereotaxic coordinates in three age groups that can be used for targeted future research in this field and discuss findings in terms of theoretical frameworks of cognitive development and reward processing (e.g., developmental triadic model).

Support is gratefully acknowledged from the Russian Science Foundation (17-18-01047).

Keywords: *rewards, decision making, development, fMRI, meta-analyses*

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II-14: The pupillary response to highly familiar complex stimuli

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Previous results showed that manipulated regions of highly familiar complex scenes are associated with distinct eye movement measures and that these measures were evident in case of explicit access to the characteristics of the change. It is also known that the pupillary response can discriminate old and new items in a recognition task (pupil old/new effect). Our main question was whether pupil size dynamics could also be used to index the detection of change in multi-element scenes. We used a scene memory paradigm, where adult participants first learned multi-element indoor scenes and later at test their task was to identify the new, repeated or manipulated scenes. Our results showed that pupil change dynamics separated new, repeated and manipulated stimuli at retrieval. According to previous results, repeated scenes elicited larger pupil dilation than new scenes (the pupil old/new effect). More interestingly, highly familiar but manipulated scenes were characterized with greater pupil dilation than repeated scenes but just when the manipulation could be expressed explicitly by the participants. This suggests that pupil dilation can index memory processes that help us distinguish old and highly familiar configurations (e.g. pattern separation).

Keywords: *recognition memory, change detection, pupil old/new effect, pattern separation*

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II-15: Integrating cognitive processes and network structure to model belief dynamics in the real world

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Belief dynamics includes processes of belief formation and change within individuals, as well as the spread of these beliefs in social networks. These processes have been studied in many disciplines, from psychology and sociology to computer science and statistical physics. However, we still don't have a good understanding of how people form their beliefs, why some beliefs are resistant to change despite conflicting evidence, and why some beliefs spread faster than others. We propose that a statistical physics framework inspired by random-field Ising models can be fruitfully used to reproduce rich belief dynamics observed in the real world, integrate theoretical and empirical observations about social-cognitive factors and network structure, and compare different models. We test the framework using data from $n = 96$ participants who completed four survey waves on Mechanical Turk, reporting their own beliefs about different science-related topics, and their perceptions of these beliefs among their friends and among scientists. Their friends ($n=203$, 1-4 for each participant) also answered the questions about their own beliefs. Modeling results suggest that perceived beliefs of closest friends have most influence on belief dynamics. Empirically grounded statistical-physics models might be able to illuminate real-world dynamics of beliefs about science and other issues.

Keywords: *belief dynamics, statistical physics, longitudinal study, social networks*

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II-16: Investigating children's sense of exhaustivity in a search task with a rake-like tool

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The concept of exhaustivity originates in logic. Whenever the outcome of an event includes the entire collection of possibilities (such that no possibility is left out) we consider this collection exhaustive. In our task, we developed two rake-like tools: one of the rake's ending was rigid, so that it could efficiently move objects that are out of reach, whereas the other rake's ending was flimsy, and therefore was less efficient to obtain such objects. With the help of these tools, 3-year-old children had to bring evidence about the presence of a reward in an opaque box. Our main question is whether the efficiency of the tools used during the search process will modulate the time necessary to comply to the exhaustivity requirements and establish whether the entire space was checked. Our preliminary data suggest that children spend more time with searching with the flimsy rake, as it takes longer to bring evidence about a presence of an object compared to a search with an efficient tool which could bring evidence in less time.

Keywords: *tool efficiency, exhaustivity, logic, search-task*

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II-17: Language affects pragmatic reasoning: The case of adjective interpretation

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We used the Visual World paradigm to investigate how adjective position affects (i) the visual search for a referent and (ii) the pragmatic processes underlying reference resolution. We compared the processing of modified definite descriptions using color, material and scalar adjectives (e.g., ‘The black lamp’) across two languages with prenominal modification (PreN: Hindi and Hungarian) and two with postnominal modification (PostN: Catalan and Wolof), spanning four language families (Indo-Aryan, Finno-Ugric, Romance and Niger-Congo). Our results confirm that, because language is processed incrementally and efficiently, speakers of PreN languages establish referential contrast across categories (black objects > the lamp), whereas speakers of PostN languages establish it within a category (lamps > the black one). More importantly, adjective position also determines whether the contrastive interpretation of an adjective is the result of a pragmatic inference (PreN languages) or incremental language processing (PostN languages). At the computational level, the highest level of abstraction (Marr, 1982), reference could be characterized as a universal pragmatic function. However, the computational problems posed by this universal function must be solved in a language-specific manner, even when interpreting equivalent referential expressions in the same visual context. We therefore conclude that language affects pragmatic reasoning at the algorithmic level.

Keywords: *adjective interpretation, visual search, pragmatic inference, Hungarian, computational-algorithmic levels*

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II-18: Music-based sleep therapy to improve sleep quality and cognitive functions in Williams syndrome

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Williams syndrome (WS) is a rare neurodevelopmental condition with symptoms of mild to moderate cognitive deficits and sleep disorder (see, e.g.: Gombos et al. J Intellect Disabil Res. 55(3):255-62, 2011).

To date, no studies have been carried out to improve sleep quality in this population, although it is known that poor sleep might deteriorate cognitive functions. Music therapy is a well-known behavioural method used in sleep medicine. The aim of the current study was to develop a music-based sleep therapy (MST) that can help WS to manage their sleep problems. Our hypothesis was that as MST improves sleep quality, cognitive performance may increase.

8 WS and 8 age-matched TD individuals participated in the study. All subjects were involved in a 30-day-long (15 min/day) MST. Subjects were tested with a set of self-reported questionnaires and a variety of cognitive tests before and after the intervention.

MST seems to be effective in terms of sleep quality improvements, however, we have not found a significant impact on cognitive performance. It might well be that the 30-day-long period was too short to alter cognitive functions. Based on the current study, an extended version of MST is planned to follow-up long term consequences.

Keywords: *Williams syndrome, sleep quality, sleep therapy, music, cognitive functions*

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II-19: The effects of novelty and expectations on human memory

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Bertalan Polner (BME TTK, Department of Cognitive Science)

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Novelty seems to influence memory processes. Accordingly, a human study found that expected novel pictures are remembered better than unexpected ones on an incidental recognition test. Functional neuroimaging indicated that this effect was driven by the anticipatory activation of relevant brain areas elicited by novelty predicting cues. We aimed to replicate these behavioural findings in two experiments. In Study 1, we used a pseudorandomised stimulus presentation order to familiarise participants with the visual cues predicting novel or familiar pictures with high probability. In Study 2 we discarded the pseudorandomisation of trials but used a textual cue to effectively inform the participants of the picture category to expect. In Study 1, participants recognized significantly more unexpected novel pictures than expected ones. This finding is in sharp contrast with the original results, but it is in line with predictive coding theories of memory function. In Study 2 there was no significant difference between the recognition of expected and unexpected novel pictures. We conclude that experimental designs have vital effects on the generation of behaviourally relevant expectations which drive learning, and this has to be considered in studies that focus on the memory effects of novelty.

Keywords: *novelty, memory, expectation, predictive coding*

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II-20: Do Expertise Differences Exist in the Understanding of Visual Analogies? - An Eye-Tracking Study

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Analogies are the prerequisites of reasoning and inference. During analogical reasoning process we create knowledge within a previously unknown area by using generalization and abstraction. Deeper connections between two fields do not prevent us from being reminded by superficial features. The question is what does influence the depth of comparison? Our goal was to separate the background mechanism behind superficial vs analogical comparisons.

In our study we use a visual analogy (scene) task: participants compare figure pairs which can be superficially similar or analogous while their eye movements are tracked. In order to investigate the role of expertise two groups participate in the experiment: graduate fine arts students (expert group) and psychology students (naive group).

Our results ($N = 22$; 13 female; $M = 24.68$ years; $SD = 2$) show clear differences in the first fixation durations between the two groups. Furthermore, we have found differences in the total fixation durations between the two types of comparisons and between the groups. The analysis of saccadic eye movements revealed that the first few fixations showed high consistency between the participants. Individual differences appeared from the fifth fixations. Involving expert participants strengthened our hypothesis related to the automatic nature of abstract analogical comparison.

Keywords: *relational reasoning, analogy, expertise, eye-tracking*

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Poster Session III -- 10.00-11.30, 25 May (Saturday)

III-01: Do metaphors bring along their literal concrete meaning? A divided visual field ERP investigation of figurative expressions

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In the present electrophysiological experiment, we aim to investigate what neural processes accompany the comprehension of novel, previously unseen metaphorical expressions. The non-conventionality of metaphors is a critical issue. It has been suggested that only novel metaphors could activate the right cerebral hemisphere (RH): figurativeness is supposedly not processed by the left hemisphere. Also, embodied cognition suggests that at least novel metaphors require sensorimotor processes for comprehension. To better understand the underlying computations, we created 270 novel metaphorical adjective-noun word pairs (e.g., “colorful prayer” and matched them with literal abstract (e.g., “uncertain prayer”) and literal concrete (e.g., “melodic prayer”) expressions ending on the same nouns. We presented the expressions in a divided visual field paradigm while measuring event-related potentials. Data acquisition is still on-going until we reach a sample of 36 participants. We predict no RH effects with stimuli matched in novelty; and metaphors to be processed similar to abstract language without evoking the concreteness effect, a late, right, frontal, negative going brainwave, or at minimum, to replicate an inverted effect: abstract metaphors evoking a greater negativity than concrete metaphors. Such results would suggest no direct role of sensorimotor computations in the processing of the content of figurative expressions.

Keywords: *language, metaphor, ERP, concreteness-effect*

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III-02: Do individuals represent the costs and rewards of coordination when deciding to act together?

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Prominent recent accounts of human social cognition propose that individuals have a basic intuition for maximising utility when they act, i.e make decisions computing trade-offs between rewards and costs and select optimal, efficient actions (Jara-Ettinger, 2016). Importantly, these theories predict that maximizing utility is a heuristic that helps individuals in predicting future behavior of other agents. At the same time, a large number of studies shows that humans engaged in joint activities incur in violations of individual utility to support short and long term coordination (Torok et al., 2019; Vesper, 2013; McEllin, 2017; Sacheli, 2013; Pezzulo, 2013; Candidi, 2015). This raises the question: do individuals compute the costs and rewards of coordination when deciding to perform a joint action? To address this question, we developed a novel joint task, where individuals are asked repeatedly to decide whether to solve a task alone, or with a partner with whom they have to synchronize to achieve the same goal. Preliminary results from a series of studies indicate that adults do not make decision based on individual utility. Instead, they prefer to solve the task with the partner and incur the extra cost of coordination.

Keywords: *joint action, utility, coordination, costs*

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III-03: Frontal hemispheric lateralization as reflected by sleep EEG spindles: sex, sleep cycle and age effects

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Dorina Ali (Semmelweis University, Hungary)

Róbert Bódizs (Semmelweis University, Hungary)

NREM EEG sleep spindles indicate trait-like and experience-dependent neural plasticity. It would be essential to reveal their functional role in cognitive processing, trait-like differences in frontal brain asymmetry, sex differences in normal and abnormal brain functioning.

Our major purpose was to reveal the sexual dimorphism in the hemispheric laterality of slow and fast sleep spindles. We analyzed adult sleep spindle data (N = 157, age range: 17-69 years, 71 females), registered from frontal EEG electrode-pairs. Women were characterized by noticeable greater amount of right-dominant sleep spindling, than men. Female vs male group differences in asymmetry indices revealed, that some of the aforementioned right laterality measures were higher in women. We found less, but significant discrepancies between age groups (in young adult and middle aged adult groups). We observed only one negligible sleep cycle-effect.

In conclusion, there is a mild, but significant right frontal hemispheric lateralization of sleep spindles in women, in contrast to men. After all, this phenomena might indicate the right-lateralization of frontal activity during waking hours. These results could help the understanding of right hemisphere related negative affectivity, as well as the higher susceptibility for affective disorders of females.

Keywords: *sleep spindles, right hemispheric lateralization, negative affection, sex differences*

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III-04: Kindergarteners' Active Use of Category Knowledge

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Anett Ragó (Institute of Psychology, ELTE Eötvös Loránd University, Budapest, Hungary)

Dual models argue for separate systems behind category learning: an implicit and a verbal learning process. Because of the late maturation of the frontal lobe, the implicit system dominates at kindergartener's age, so they should acquire information-integration tasks easily. However, in case of complex visual categories they mostly categorize by chance. Our goal was to develop a long-term training information-integration task where implicit acquisition of new categories is possible.

21 children age of 4-5 participated in a four-session training in four consecutive weeks where they got familiar with 8-8 far-from-prototype exemplars (32 in total) of 2 categories according to a complex family resemblance structure. In test phase they had to create an exemplar of each category with features given to them.

We found that children were able to create exemplars that matched the category. Most of them created the category-prototype, but some children created far-from-prototype exemplars.

Knowledge transfer in case of kindergarteners is more difficult to trigger because of the lack of source memory information. However, in this study we showed with prolonged training this effect can be avoided and children can make abstractions to actively create the category-prototype.

Keywords: *kindergarteners, categorization, category learning*

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III-05: Modeling executive functions in the prefrontal cortex

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Numerical methods related to reinforcement learning or bayesian inference have demonstrated impressive performances, solving some difficult tasks of decision making. Yet some ingredients must be reconsidered, as one aims at defining a cognitive agent demonstrating executive control in ecological conditions. Three fundamental dimensions are underestimated. The agent must be autonomous, cumulating its experience throughout time and with a proper motivation to act. The environment might display characteristics like volatility and stochasticity, with no preliminary segmentation of information. Its computational power complexity must be bounded in space and time. Inspired by knowledge and data from neuroscience and cognitive science, we develop a bio-inspired cognitive architecture taking a more realistic account of these dimensions. We model, in the orbital and medial regions of the frontal cortex, a series of territories representing subtle mappings of stimuli preferences and costs of actions. They are exploited for emotional and motivational control, sliding from respondent to operant representations. This analysis of internal goals and needs is used by our model of lateral prefrontal cortex to bias the default reactive behavior learned to answer external stimuli. Our model is assessed in both classical tasks and more realistic navigation in a virtual environment.

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III-06: The effect of referential uncertainty on encoding novel words

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Learning new words relies on processes that work at multiple time scales - learners need to identify the referent, encode a mapping between the label and the referent, and use their learned mappings to identify the object in novel contexts (Yurovsky et al., 2017). Describing this process requires understanding how those cues learners use to identify referents interact with attentional and memory processes (Frank et al., 2013). Our study aims to extend the existing knowledge about word learning by investigating whether and how referential certainty might influence encoding processes. We show short movies about a person providing a novel word in the presence of two unfamiliar objects. At test, subjects' recognition of the previously heard words is assessed. To modulate certainty about the meaning of the novel words we vary two factors: object identity (using two identical or two different objects) and referential cues (pointing at one of the objects or not). Our hypothesis is that different levels of certainty about the meaning of the word will influence the depth of encoding. Our prediction is that the least certainty is the better the encoding will be. Data collection is currently ongoing, and we believe that the results will enrich our current understanding of factors that can have an impact on the depth of encoding novel words at a very early stage, when encoding of the meaning doesn't necessarily occur yet. Furthermore, this project may also provide an opportunity to test in general the relationship between memory encoding and certainty about the meaning of incoming information.

Keywords: *word acquisition, referential certainty, memory encoding, word recognition*

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III-07: Studying the temporal dynamics of analogy-making in children and adults with eyetracking data: scanpath-comparisons, machine-learning classification algorithms and data predictability

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In recent years eye-tracking has begun to be used to study the dynamics of analogy making. There are numerous scanpath-comparison algorithms and machine-learning techniques that can be applied to the raw eye-tracking data. We used machine-learning classification algorithms to examine the item-to-item saccade vectors making up these scanpaths. We show which of these algorithms best predicts from very early on in a trial, based on the frequency of various item-to-item saccades, whether a child or an adult is doing the problem. This type of analysis can also be used to predict, based on the item-to-item saccade dynamics in the first third of a trial, whether a problem will be solved correctly or not.

We illustrate our methods with children' and adults' data: significant differences between age groups in exploration strategies. Looking patterns associated with errors and correct trials differed from the start of the trial, suggesting that different search strategies lead to different outcomes. Adults also show how they fine-tuned their search behavior, depending on the analogies levels of difficulty. Our learning and classification techniques allowed us to identify which transition types (switches) were the most discriminative and predictive.

Keywords: *analogy, reasoning, eye-gazes, machine-learning, prediction*

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III-08: Changes in mechanisms of implicit, complex visual image categorization during aging

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Categorization mechanisms of people seem to become less efficient as they age. Furthermore, there's an ongoing debate on the involvement of the implicit and explicit categorization systems on this phenomenon.

We analyzed the data of 60 adults (18-50 y) and 60 elders (50+ y), who participated in a family resemblance based complex visual categorization experiment. The method attempts to measure the implicit categorization mechanisms, by driving participants' main focus on a controlled feature, by exploiting their one-dimensional bias during the learning phase. During the test phase this feature is unavailable, forcing participants to rely on their implicit knowledge.

Results show, that the family resemblance structure and the age both have a main effect on category decision response times, showing that both groups categorize effectively, and also showing general deceleration for the elder group. On the other hand, age doesn't seem to have interactions with the measured categorization attributes, suggesting there might be no structural difference in the implicit categorization between the two measured groups.

Keywords: *categorization, statistical learning, implicit learning, category learning*

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III-09: EEG Classifications: The Warping Window Size Does Not Matter That Much

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EEG classification is the common theoretical background of various EEG-related recognition tasks, such as the recognition of symptoms of diseases. We consider these tasks as time series classification tasks for which models based on dynamic time warping (DTW) are popular and effective. According to the recent study by Dau et al. (2018), setting the appropriate warping window size (WWS) is crucial for the accuracy in various applications. We examined whether the WWS is crucial in case of EEG classification. We considered two DTW-based methods, nearest neighbor and a more advanced approach, PROCESS. We performed disease recognition experiments on a publicly-available dataset according to patient-based 10-fold cross-validation and measured the area under receiver operator characteristic curve (AUC) for both models with various WWS. A reasonably high accuracy is achieved in a relatively wide range of WWS, although WWS should not be set to zero. The AUC of the best examined model was around 0.875 which we achieved with relatively low WWS corresponding to approximately 170 milliseconds. Our observations indicate that in case of EEG classification, the examined classifiers are much less sensitive to the WWS than suggested by Dau et al.

The work was supported by the Institutional Excellence Program in Higher Education of the Hungarian Ministry of Human Capacities (20460-3/2018/FEKUTSTRAT), the Hungarian Government and the European Social Fund (EFOP-3.6.3-VEKOP-16-2017-00001).

Keywords: *EEG classification, dynamic time warping (DTW), warping window size*

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III-10: Privileged Access: What Do We Know about Bilinguals?

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Cognitive psychology studies in the past decades have sought to find out when and how a child's ability to attribute privileged access to others' mental states develops, yet there are little evidence regarding the development of attribution of privileged access in bilingual children.

This research aims to describe the development of this ability in bilingual children. The research questions are the following: 1) at what age do bilingual preschool children acquire the attribution of privileged access? 2) to what extent do bilingual children benefit from their linguistic background? 3) are there differences in development depending on the type of bilingualism. My hypothesis is that the attribution of privileged access appears sooner at early, simultaneous bilingual children than at those who are early, but successive bilinguals.

60 Hungarian-Romanian bilingual children, aged between 4 and 6 participated in the experiment. Simultaneous and successive bilingual children groups were established using a questionnaire filled in by the parents of the children. The participants had to listen to different stories and answer questions about the characters' mental states. The results support the hypothesis that the attribution of privileged access to mental states develops faster in bilingual children.

Keywords: *privileged access, preschooler, bilingualism*

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III-11: Brain activity and hemispheric dominance in response to increasing complexity of mathematical calculations

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The Right-Left-Right hypothesis suggest that hemispheric dominance depends on the trade off between the cognitive demand (i.e., difficulty) of the task and mental attentional capacity of the individual. Mathematical problems lend themselves for testing this hypothesis, as some math problems can be very easy ($1+4$) and others more difficult (e.g., 17×24). We expect that very simple and automatized actions are more likely to activate the right hemisphere, whereas during effortful tasks within the individual's cognitive competency we expect to see higher involvement of the left hemispheres. When the task demands are above and beyond the mental attentional capacity, the right hemisphere is expected to be active. We tested 20 adults (10 females, mean age 22.85 ± 3.27) with addition, subtraction, multiplication and division problems with three difficulty levels (easy, medium and high) using functional magnetic resonance imaging and behavioural measures of mental-attentional capacity. Data will be processed to identify the mental-attentional capacity of the individual and evaluate the relation between behavioural performance levels and fMRI signal. Results will be discussed within current models of mathematical cognition and cognitive control.

Keywords: *fMRI, hemispheric dominance, mathematical calculations*

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III-12: Test-retest reliability of canonical reinforcement learning paradigms

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Reinforcement learning (RL) paradigms are commonly used in Cognitive Science research on human learning. Given their prevalence, it is surprising that the test-retest reliability of some canonical paradigms has not been established.

The present study seeks to close this gap by testing the test-retest reliability of two canonical RL paradigms: a probabilistic RL task with gain and loss feedback (Pessiglione et.al, 2006) and a reversal learning task (Cools et.al, 2002; Schlagenhauf et.al, 2014).

This study obtained test results from n=150 participants for each paradigm via the online testing platform Amazon Turk with a between-test interval of five weeks.

Test-retest reliability is being studied in regard to behavioural measures such as accuracy and reaction times. Additionally, a Rescorla Wagner model is fitted to the choice data in R as well as in Stan to study the test-retest reliability of resulting parameter estimates. This is relevant because these paradigms are additionally increasingly relied upon in the field of 'computational psychiatry' to discern learning mechanisms and infer mechanism dysfunction in psychiatric patient groups (Huys et.al, 2016; Montague et.al, 2012).

The working hypothesis is that both paradigms achieve high test-retest reliability in behavioural measures as well as in computationally estimated parameters underlying the choice behaviour.

Keywords: *reliability, reinforcement learning, reversal learning*

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III-13: Same Words, Same Context, Different Meanings: People are unaware that their own concepts are not always shared

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Celeste Kidd (University of California, Berkeley)

A long-standing assumption in cognitive science has been that concepts are shared among individuals for common words. However, given that concepts are formed by the data we observe, and observations vary wildly across individual experiences, our concepts are not likely identical. Here, we present data in which 104 participants answer questions regarding their beliefs about the definitions of common everyday words, and the degree to which they think others agree. Using a Bayesian clustering algorithm and an estimator drawn from Ecology, our results suggest that even for common words, there exist many distinct extensions of ordinary and political concepts across individuals. There is also a pervasive bias which leads individuals to overestimate the degree to which others agree, which may explain why “talking past each other” is an anecdotally common experience when discussing important topics.

Keywords: *concepts, metacognition, individual differences, miscommunication, computational modelling*

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III-14: Ways of thinking about time and coping with negative affect

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Negative mood may cause discomfort, and even lead to mental and physical disorders. Dealing with negative emotions is therefore one of the most human abilities. This ability is determined by a number of factors. The aim of this study was to examine correlations between the extraversion, abilities to cope with bad mood and thinking about time in the ego-moving and time-moving categories. The research was experimental in nature. The extraversion was measured using the Extraversion with NEO-FFI scale, coping with negative moods was measured using questions about predictions on coping with negative emotions and by measuring the affective state following bad mood induction. The way of thinking about time was measured by the Wednesday question and a selection of sentences about an exam and summertime. There were 502 participants. The results show that extroverts coped better with negative mood when they thought of time in the ego-moving rather than the time-moving category. In the case of introverts, no significant relations were observed between how they perceived time and how well they coped with negative mood. Among other, the embodied cognition theory was used to interpret the results.

Keywords: *ego-moving, time-moving, mood*

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III-15: ‘I don’t know but I know who to ask’: 12-month-olds actively seek information from knowledgeable adults

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Active social communication is an effective way for infants to learn about the world. Do preverbal infants pose epistemic requests to their social partners when motivated to obtain information they cannot discover independently? The present study investigated whether 12-month-olds selectively seek information from knowledgeable adults in situations of referential uncertainty. In a live experiment, infants were introduced to two unfamiliar adults, an Informant (reliably labeling objects) and a Non-Informant (equally socially engaging, but ignorant about object labels). At test, infants were asked to locate a novel referent among two novel objects - that is, to make an impossible choice. Infants selectively referred to the Informant rather than the Non-Informant, but showed no such preference at the familiarization and training phases, when no uncertainty was present. These results suggest that preverbal infants use social referencing to actively and selectively seek information from social partners, prior to their active use of pointing as part of the interrogative communicative toolkit.

Keywords: *information seeking, social referencing, social cognition, active learning, epistemic requests*

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III-16: The fine structure of eye movements reveals predictive internal models of dyadic agent dynamics in 14-month-old infants

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Humans employ rich internal models to make predictions about and interact flexibly with the environment. Eye movements have been shown to reflect sophisticated cognitive operations relying on such internal models and their measurement thus potentially offers a window onto how subjects develop and employ their internal models. However, studies of infant cognition typically only use very simple measures of eye movements, such as relative looking times between two discrete targets, which provide limited information about their internal models. Here we used statistically principled maximum likelihood-based methods to analyse the moment-by-moment fine structure of pursuit and saccadic eye movements of 14-month-old infants while subjects viewed dynamic scenes including two, potentially interacting agents. We found that subjects' gaze followed more predictably moving agents with a smaller time lag, consistent with an understanding of dyadic interactions between agents, and these time lags were consistently smaller than those of purely reactive eye movements in response to non-predictable events in the scene. These results provide quantitative evidence for rich internal models of complex, multi-agent scenes in young infants.

Keywords: *infant, eye movements, predictive internal models*

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III-17: Active Learning Across a Sequence of Tasks: Adapting to Change

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The problem of learning across a sequence of different tasks is a difficult one, yet one that we face everyday. In order to act, plan, and achieve goals, people must learn about their environment and the outcome of possible actions. When faced with new situations, people are often faced with the decision of either gathering more information about the task to improve the quality of their decision, or choosing an action that has been shown to be rewarding. We present experiments that aim to better understand people's exploration and reward maximizing strategies across a sequence of tasks. Our results show that people are able to detect change efficiently, even in the case of abrupt and unobservable change. On top of this, they display evidence for faster learning rates when repeatedly confronted with tasks of similar nature. In some cases however, participants were consistently unable to detect change, and behaved for an extended period of time oblivious to a change in the underlying structure of their environment. We present modelling results to account for the mechanisms of human exploration and learning that give rise to these seemingly conflicting behaviours.

Keywords: *active learning, explore-exploit, change, heuristics*

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III-18: Preschoolers' Metaphor Comprehension in Causal Contexts

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Previous work argues that children's ability to understand metaphors emerges late in development. Gentner (1988) argues that analogical reasoning underlies metaphor comprehension, and attribute children's failure to understand metaphors to an inability to notice shared relational structures between concepts. Recent work shows that causal framing facilitates analogical reasoning in preschoolers (Goddu et al., 2017). Thus, we examine whether causal framing might also facilitate preschoolers' metaphor comprehension.

4- and 5-year-olds participated in a game involving causal training trials and metaphor test trials. All metaphors involve concepts that share similar relational structures, namely the same functions. During test trials, preschoolers hear both metaphors (i.e. 'Roofs are hats!') and nonsense statements (i.e. 'Dogs are scissors!') and must determine whether each statement is 'smart' or 'silly'. Preschoolers rated metaphors as significantly smarter than nonsense statements. However, they were at chance judging whether metaphors were smart or silly; possibly, preschoolers hesitate to accept metaphors as 'smart' because metaphors are literally false.

Thus, on-going work explores preschoolers' performance when presented with literal similes (i.e. 'Roofs are like hats!'), with and without causal training. Overall, these experiments explore how domain-general processes like causal and analogical reasoning contribute to the development of specific linguistic abilities like metaphor comprehension.

Keywords: *metaphor, analogical reasoning, conceptual structure*

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III-19: Examining the relationship between the comparison distance effect and the priming distance effect in numerical cognition

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In regards to the number comparison task, the correlation between the comparison distance effect (better performance with larger distance between two numbers, CDE) and the priming distance effect (better performance with smaller distance between the priming and target number, PDE) has been studied before. The Analogue Number System explanation of numerical cognition predicts a strong correlation, while an alternative model, the Discrete Semantic System account doesn't. Previously no correlation was found, however, previous studies didn't account for the reliability of the two effects. Low reliability can mask the correlation as it sets an upper limit on the retrievable correlation coefficient. The goal of the present study was to measure the correlation between the two effects, correcting the observed correlation with the reliability of the variables, based on Spearman's (1904) method. We found that the reliability of the PDE was practically zero, and the correction method would not yield a meaningful result for the correlation coefficient. We have set out to develop data analysis and statistical methods to increase the reliability of the PDE. To closely monitor the reliability of the PDE we use both classic and bootstrapping approaches. To fix the reliability of the PDE we use multiple linear regression.

Keywords: *numerical cognition, comparison distance effect, priming distance effect, reliability*

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III-20: Depression, Social anxiety and Coping Strategies - empirical study of congenital prosopagnosia

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People with congenital prosopagnosia cannot recognize faces, even though they have normal cognitive functions and proper visual skills. Prosopagnosia can have a severe impact on people's lives, resulting in problems with social interactions, interpersonal relations, and depression. Accordingly, almost 100% of the prosopagnosia reports start with the following key sentence: faces - and the recognition of faces- play an inevitable role in everyday human interactions since we are social agents. However, the vast majority of these studies missed the systematic investigation of these psychosocial features and concentrate only on the neural background mechanisms of the disorder.

To this end we aimed to study social and personality-related psychological factors in relation to high-level visual functions of facial recognition in congenital prosopagnosia. We recruited individuals for this study using online neuropsychological tests and questionnaires. In addition to the basic diagnostic test, the Cambridge Face Memory Test, we tested coping strategies (CISS-48), depression (BDI), trait anxiety (STAI-T) and social anxiety (FNE-8). Our results suggest that individuals with prosopagnosia show differences psychologically as well. The current investigation not only expands our knowledge of the disorder, but it can also emphasize the necessity of professional help in prosopagnosia.

Keywords: *prosopagnosia, depression, coping, social anxiety, personality*

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