

# COGNITIVE SYSTEMS MODELING



7TH PERIPATETIC CONFERENCE

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Abstract book

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# About the conference

The Peripatetic conferences on Cognitive Systems Modeling are organized since 2010 by and for those who appreciate thinking and exchanging ideas while walking and those who, like many before, believe that the rarefied mountain air and the physical exertion bring our brains to another level of functioning.

Cognitive systems are defined through their ability to adapt to the ever-changing conditions of the environment. We observe such processes of adaptation on many different levels: from single cells and tissues, through regulation systems such as the immune system, to people operating on conscious level and whole social groups. The aim of the conference is to present recent research on cognitive systems from multitude of perspectives and methodologies, and to bridge gaps between different disciplines in order to develop common language as well as new methods and paradigms for modeling cognitive phenomena.

Among the participants of the previous editions of the conference were psychologists, cognitive scientists, computer scientists, linguists, physicists, biologists, mathematicians, anthropologists, sociologists (see previous abstract books: 2016, 2017 (PL)). No matter what is your discipline, what counts is your interest in cognitive systems, your openness to talk to others and your love for the mountains.

# Around Information – Information Around

One would think that if a domain defines itself with a certain concept, this concept should be understandable in a roughly uniform way by the sub-disciplines, creating a common ground rather than instigating lively debates. Cognitive science is a curious discipline: it is often defined as a study of how systems get, process and use information. Yet the concept of information still, after more than half century of the field's successful development, in important aspects remains vague.

Shannon's information theory proposes how to measure the amount of information based on the difference in states that we consider informative. However, what should count as a difference in states (a "difference that makes a difference") is far from clear, both on the theoretical and operational level. What is it that the intelligent systems "pick up" from the environment, what does it mean that organisms "process" it? What are the time-scales of relevant events? What are the bits (information units) and how the "bits" cohere in complex flexible arrangements? One of the central questions is if these arrangements are due to the individual and internal brain processes or rather the information around is already rich, in some sense "preprocessed" by the virtue of how our bodies are built and by the construction of the environmental (physical and social) niches around the organisms.

Thus this year's topic of the 7th Peripatetic Conference revolves around "information" and "information around" as the unifying thread of research on various levels of cognitive systems' organization: from molecular to neural to social. Even though a certain prominence will be given to language and communicative processes, the above questions emerge at any of those levels. In many current research domains within the cognitive science they seem to be backgrounded or avoided entirely for pragmatic reasons, under the assumption that the established methodologies and operationalization can be relied on. We hope that the informal nature of the Peripatetic conference will create an atmosphere where even such basic questions can be boldly asked, answers proposed and searched for together, and lack of answers admitted.

# Invited talks

## Dialogue in the making, or working with clay



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The instrumental, intentional, social, cultural and normative aspects of human cognition all have been thoroughly investigated, whereas the aesthetic aspects of cognition remains understudied. Yet aesthetic concerns permeate human activities and have been shown to be inherent to human forms of life throughout human history. The present talk relates to an on-going interdisciplinary project about the cognitive underpinnings of aesthetic experience and making in the arts and (manual) crafts. Conceiving of cognition as physically embodied and socio-culturally embedded, I approach it from a dynamic systems perspective that allows for modelling cognition as a variable process that develops in real time by interaction between agents and context. I will talk about making in pottery and illustrate how the dynamic systems framework can be used to analyse what goes on. I hold that throwing draws on processes of sensorimotor entrainment and emotional engagement, and submit that this can explain the widespread experience of throwing among potters as having a dialogue with clay. The analysis suggests that cognition involves similar functions across domains, and moreover, that humans tend to take an intersubjective stance to materials in contexts of making. Finally, I will say a few words about the notion of information in the present framework and how it differs from the traditional view.

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## Two heads are better than one: The emergence of triadic interaction



Thea Cameron-Faulkner

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One of the most important behaviours exhibited by humans is our ability to engage in and initiate triadic interactions, that is interactions in which two (or more) people share attention with each other and some form of external entity. When we see a beautiful sunset or witness a distressing event we look to others to share our experience with. The ability to engage in information-rich triadic or 'joint attention' episodes is a crucial skill which allows us to access information in our environment in meaningful ways (e.g. Tomasello, 1999) and is fundamental to the success of the human species. This ability takes months to emerge in human infants prior to which they can pay attention to objects, or people but not to both at the same time (e.g. Adamson and Bakeman, 1991). At around 10 months of age infants begin to initiate triadic interactional episodes such as holding up objects towards caregivers and producing index-finger points (e.g. Bates, Camaioni, & Volterra, 1975; Cameron-Faulkner, et al., 2015). These triadic bids herald a new way for infants to interact with and learn about their environment and typically elicit rich interactional episodes between caregiver and infant (e.g. Cameron-Faulkner, Theakston, Lieven & Tomasello, 2015). Studies indicate that the episodes have a strong influence on a range of subsequent developmental processes such as language development and theory of mind (e.g. Tomasello & Farrer, 1986; Carpendale and Lewis, 2004). In this talk I'll focus on how infants develop the ability to engage in and initiate triadic interaction. I'll discuss some of the key theoretical perspectives that have been proposed to account for the emergence of triadic interaction and challenge some of the assumptions that underlie our established methodologies and theories.

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## Developmental Robotics for Language Learning, Trust and Theory of Mind



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Growing theoretical and experimental research on action and language processing and on number learning and gestures clearly demonstrates the role of embodiment in cognition and language processing. In psychology and neuroscience, this evidence constitutes the basis of embodied cognition, also known as grounded cognition (Pezzulo et al. 2012; Borghi & Cangelosi 2014). In robotics, these studies have important implications for the design of linguistic capabilities in cognitive agents and robots for human-robot communication, and have led to the new interdisciplinary approach of Developmental Robotics (Cangelosi & Schlesinger 2015). During the talk we will present examples of developmental robotics models and experimental results from iCub experiments on the embodiment biases in early word acquisition and grammar learning (Morse et al. 2015; Morse & Cangelosi 2017) and experiments on pointing gestures and finger counting for number learning (De La Cruz et al. 2014). We will then present a novel developmental robotics model, and experiments, on Theory of Mind and its use for autonomous trust behavior in robots. The implications for the use of such embodied approaches for embodied cognition in AI and cognitive sciences, and for robot companion applications will also be discussed.

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## Satisficing trumps imprimizing in human communication



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The dominant models of human communication all share the assumption that, when people communicate, they aim to optimize the informational transactions they perform. The assumption has a wide scope, ranging from the minimization of physical noise to the systematic repair of conversational breakdowns. In this talk I will present evidence suggesting that the assumption might reflect an unrealistic idealization.

An earlier indication that this might be the case comes from research showing that, because of cognitive biases, people do not always perform all of the steps necessary to prevent communicational breakdowns. This is typically viewed as a failure in using the ability to optimize communication. To my knowledge, the possibility that people might not even aim to optimize their communicative interactions has not been entertained before. In a series of studies performed in my lab, we have gathered evidence suggesting that this possibility might very well be real.

The first two studies focused on spontaneous conversations over instant messaging. In one of them, we crossed the conversations of two pairs of participants a number of times (a bit like when a phone call is mixed with another) and found that it is not uncommon for people to not notice the crossings. The second study replicated the first but with odd messages we created and inserted. Again, people did not notice the odd insertions, even when they contradicted basic information they had (e.g., the message referred to a participant as “a man” when she was a woman and this was well known to the conversational partner).

In the third study, we upped the ante in two ways. First, we focused on spontaneous face-to-face conversations with a confederate. Second, the odd message inserted was “colorless green ideas sleep furiously”, a sentence which was bound to be incoherent in any conversational context. Again, it was not uncommon for people to not notice the incoherence.

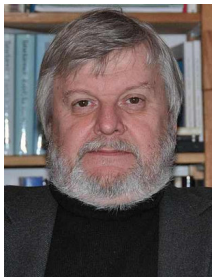
In the fourth study—which is currently in progress—the odd insertion has a concrete interactional impact. Participants play a simple communication game in which they are asked by a confederate to move a number of objects on a chessboard. After a few mundane turns, the confederate

requests that “the skask” be moved. Although “skask” is a non-word and the object picked up by the participant is in clear view, we have already observed a number of participants who completed the move without initiating a repair sequence.

I will conclude by arguing that the results of these studies suggest that human communication—much as human cognition—prefers satisficing over optimizing and, precisely for this reason, it constantly lives on the brink of failure.

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## Quantum vs. Classical Machine Learning



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An unparalleled development of quantum information theory we have witnessed for nearly twenty five years has not lead, up to now, to groundbreaking achievements in the area where promises were most attractive, namely quantum computing. Employing principles of quantum physics to perform information-theoretic task can, in principle, revolutionize computing making it faster. Alas! Even putting aside technical problems of constructing a quantum computer we are confronted with a modest (to put it mildly) number of interesting quantum algorithms. (In fact, only two such algorithms can be honestly quoted: the quantum Fast Fourier Transform that is a basis of the Shore algorithm potentially useful in breaking almost all public-key cryptography systems and the Grover algorithm speeding up databases searches). Recently however various ideas using quantum principles to achieve such tasks like machine learning or finding patterns in huge amounts of data were proposed. In my short talk I will address these topics and prospects of attacking such an ambitious tasks by quantum physical methods.

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## Cognitive scientific research on human-chatbot interaction



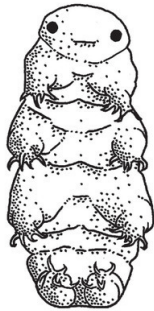
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Chatbots are increasingly frequently used in business to facilitate various processes, particularly those related to customer service and personalization. In this paper we are proposing novel methods of tracking human-chatbot interactions and measuring chatbot performance that take into consideration ethical concerns. Our proposed methodology links neuroscientific methods, text mining and deep learning with the issue of trust allocated in chatbots and their overall transparency. Moreover, we argue that trust is the focal point of successful human-chatbot interaction and assess how trust as a category is redefined with the advent of deep-learning supported chatbots. We have previously conducted the first of its kind study of human-chatbot online interaction (Ciechanowski et al. 2018; Ciechanowski, Przegalinska, and Wegner 2018), using both subjective (questionnaires) and objective (psychophysiology) measures. In this article we propose a novel method of analysing the content of messages produced in human-chatbot interactions, using the Condor Tribefinder system developed by us for text-mining (De Oliveira and Gloor 2018; Gloor et al., n.d.), which is based on machine learning classification engine. Our results may be of significant use in the domain of building better social bots for interaction in business or commercial environments.

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# Regular talks

## Biological Information in Two Aspects: Correlative and Normative



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The following paper puts forth the position that biological information and mental representation are characterized by two fundamental aspects: a correspondence aspect, and a normative aspect. The correspondence aspect, I contend, can be naturalized by appeal to a selection history—exemplified by the teleosemantics tradition (Millikan, 1984; Papineau, 1984), which imposes an inherent salience constraint on epistemic access, as exemplified by the Uexküllian–Gibsonian notion of affordances (Uexküll, 1957, 1980; Gibson, 1966, 1979). The normative aspect, however, can only be naturalized by appeal to the nature of the organism—as autonomous, self-maintenant far-from-thermodynamic-equilibrium system. Contributions to this secondary aspect of representation are explored in the emergent-constraint theory of Deacon (2011) and the interactivist perspective of Bickhard (2009). This paper defends a perspective on life as inherently representational and informational, and makes a case for this as the only tenable approach to a meaningful theory of life-mind continuity.

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## Transition entropy of eye movements during flight simulation



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In our research, we recorded eye movements during flights in the simulator to find indices of expertise. We looked for differences between experts (pilots) and amateurs (non-pilots) in the transition entropy of gaze patterns during several flight profiles. The experiment was carried out in the Military Institute of Aviation Medicine in Warsaw. The subjects (20 pilots; 20 non-pilots) have undergone a series of tasks in the flight simulator GYRO-IPT. During flight eye movements were recorded. Comparison of entropy transition in experts and novices showed significant differences between groups. The pilots presented higher value of the entropy, than non-pilots. It means that non-pilots were choosing the specific places to look at and the sequences of gazes in various regions were not accidental. Probably, experts collect visual information more effectively and cope better with changing requirements of a task, so they have lower workload and can check indicators less relevant to the task.

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## From ritualization to conventionalization – another take on development of pointing.

AB

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Infant's use of pointing gesture introduces reference into communication, which is later used by words, and thus marks an important developmental milestone. At the same time explaining development of pointing remains the challenge for developmental psychology. Treating pointing as fundamentally social activity, we claim that infants' actions get meaning due to embedding by the caregivers into holistic sensible events. Referring to classical ethological works on development of communication (Tinbergen; Smith) as well as to psychological research on roles of caregivers in structuration of early infants' activities (Bruner; Uzgiris; Kaye) may shed the light on fundamental

processes taking part in development of pointing. Thus we contrast two ways of explanation of pointing behaviour: 1) ontogenetic ritualization (i.e. abbreviation, shortening action sequence) and 2) conventionalization (i.e. schematization, simplification and stylization of action), and show that only the later process allows for co-constitution of meaning and acquiring bi-directional signals. Additionally, analysing development of pointing in semiotic terms (Peirce; Kockelman; Enfield) might be helpful for understanding it. (submitted together with Joanna Rączaszek-Leonardi)

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## Application of Dynamical Systems Theory to the Parcellation of the Human Amygdala



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Parcellation of brain areas might be performed on the basis of four different characteristics: cytoarchitectonics, topography, functional properties or connectivity patterns. As in the case of the human amygdala different parcellation methods yielded inconsistent results, we argued that the BOLD signal dynamics might be introduced as the next feature allowing differentiation of the amygdala subdivisions. We applied the Recurrence Quantification Analysis (RQA), a technique known from the Dynamical Systems Theory (DST), to time-series from the amygdala. The fMRI data were collected from 36 subjects (25 – 30 years old males) during the 15-minute rest period (Simens Vario 3T, TR = 1.4 s., voxel- size = 2.3x2.3x2.3 mm). Results indicate that the Trapping Time (TT) measure allows delineating two units within the amygdala. This parcellation result is consistent with the effects of parcellations performed on the basis of structural connectivity patterns and cytoarchitectonics. Thus, the RQA seems to be a valuable approach for the analysis of resting-state fMRI data and for in vivo parcellation of brain areas. The study was supported by the grant from the National Science Center (Poland) based on decision number DEC-2014/15/B/HS6/03658.

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## Measuring information in biological networks



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The availability of high-throughput genome sequencing techniques and the development of computational methods in general allowed the emergence of genomics as a field of study, significantly shaping modern biology. As large amount of biological data is being produced, researchers in bioinformatics draw from fields like graph theory in order to analyze relations between, among others, genes and proteins. We focus on applying information-theoretic measures to analysis of such networks. A number of methods were developed for this purpose; These range from simple reformulations of well-known graph measure distributions (node degree, centrality, homophily) in terms of entropy, up to computational measures approximating Kolmogorov complexity. We show, basing on own research as well as literature, how such approaches can be useful in analyzing genomic data, to study its organizational structure – in particular, how division of the (human) genome into relatively spatially isolated regions can be seen as an informational phenomenon. We also show the possibility of application in other domains, such as analysis of social networks. While research in these recently emerging fields sheds new light on how information is encoded and processed in biological systems, it also raises the question of how we should measure information in such systems, and how it should be defined altogether.

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## Three Power Laws Which Show That Language Is Not A Finite-State Process



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Finite-state processes are hidden Markov processes with a finite number of hidden states. In the talk, we will argue that finite-state processes are insufficient as models of natural language. The idea is not new. It dates back to a famous debate between Burhus F. Skinner and Noam Chomsky (Skinner, 1957; Chomsky, 1959). Skinner believed that finite-state processes, with a sufficiently large number of hidden states can account for human language behavior. In contrast, Chomsky showed that if the syntax of natural language is described by a context-free grammar then natural language cannot be adequately described by finite-state formal languages or processes. Chomsky thought that rejecting finite-state processes means eradicating any probability models from linguistic considerations. In the talk, we will argue that this view is too radical. There exist stochastic processes which are not finite-state and we observe at least three different quantitative linguistic power laws which imply that natural language is not a finite-state process. The first power law concerns the growth of mutual information between two adjacent text blocks of increasing length (Hilberg, 1990), the second power law concerns the growth of maximal repetition in an increasing text fragment (Dębowski, 2012), whereas the third power law concerns the decay of mutual information between two letters separated by an increasing number of letters (Lin and Tegmark, 2017).

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## Mind after Uexküll: On Baggs and Chemero's use of the term Umwelt and its wider implications for the Philosophy of 4E Cognition



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independent

In “The third sense of environment” (forthcoming), Edward Baggs and Anthony Chemero call into question the status of the terms affordance and information, foundational terms of Ecological Psychology and thereby of Radical Embodied Cognitive Science (RECS), a significant part of the heterogeneous ensemble of trends within cognitive science which are united under the label of 4E cognition. They do this by introducing Uexküll's term *umwelt* into debates which have been tacitly informed by the work of this pioneer of biosemiotics but which until now have failed to address the deep philosophical challenges it entails. Baggs and Chemero amend the distinction between physical world and the meaningful environment of animals by further distinguishing the latter into the habitat of a species and the *umwelt* of a single organism. Although they show that this move might help resolve many long-standing issues, I argue that it might raise more questions than it answers. This results from their particular use of the term *umwelt*. In my talk, I will compare the use of the term *umwelt* in this paper to Uexküll's original conception and draw on some of the debates around it to elucidate central issues of 4E cognition. By considering the question of selection vs. construction and the relationship between *umwelt* and physical space, I will highlight some of the challenges that result from Uexküll's insights for the position of direct realism and investigate how this move by Baggs and Chemero changes the relationship of Chemero's RECS to the extended and enactive strands of 4E cognition.

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## A bionic speaking aid



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Over the past 15 years we have been in the process of developing a speaking aid for people who lost their larynx. We started out trying to improve specific aspects, but learned over time that we have to always consider the whole system. In the end we want to enable the user to convey as much information as possible that a speaker would be able to transmit when using a healthy voice. This includes engineering aspects such as digital signal processing or acoustics, medical issues and human computer interaction, to name just a few. In our current research project we are looking specifically at diversity aspects and investigating the needs of different groups, female or male, young and old, academic or farmer. Methods from participatory design have brought us into the everyday environments of electronic speaking aid users and experiencing first-hand the difficulties and requirements in user specific contexts. Discussions with various stakeholders have allowed us to develop a differentiated view of the problem. During those years our system has grown from an offline only demonstrator to a real-time speaking aid that is currently implemented on a raspberry pi. In this talk I will share the most important learnings along the way and discuss the challenges still ahead.

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## Grammatical structures as a means of regulating interpersonal relations: A note on the grammar of verbal abuse



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The present paper is a case study of how grammatical structures may be employed as tools of verbal abuse. The analysis will focus on the following examples: (1) a. Usiądzie (lit. sit-down)<sup>3</sup> SG. NON-PAST PERF. INDICAT. 'Have a seat' b. Podniesie<sup>3</sup> SG. NON-PAST PERF. INDICAT. koszulę do góry 'Raise [your] gown' (2) Pokazać<sup>INF</sup>. krocze 'Show the crotch' The examples under consideration come from "The report from the monitoring of obstetric wards. The perinatal care in the light of women's experience", a yearly report prepared for the year 2017/2018 by the Childbirth with Dignity Foundation in Poland. In the report, the examples in (1) and (2) were all listed as instances of the most abusive utterances that were directed by members of the medical personnel at women giving birth to their children in Polish hospitals in the year 2017/2018. The question that I would specifically like to address is why exactly the examples under consideration may be found strongly abusive. This, in turn will lead to considering briefly the wider issue of the mechanism via which grammatical resources may be used as tools of communicating a wide range of interpersonal meanings.

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## Amor vincit omnia, or a plot-driven theory of mind



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Thorough cognitive theories of fictional narratives prevails an assumption that „unless there is a reason to think otherwise, reader assume that fictional context operates in the same way as real-life ones.” (Emmott, 2003). Theory of comprehending events and behaviors as/by schemas (scripts/scenarios) is commonly applied. Mimesis is seen in those cases as default. It seems so intuitive that it’s enough to just state (Emmett) or even just imply (Steen) it in one’s research without further explanation. Yet works of film theoretic (i.e. Bordwell) suggests that the comprehension of filmed narrative requires from the audience more than recognition and recollection. In a filmed narrative-differently from written ones-most of the information needed to reconstruct fictional reality is rather hinted than given. Instead of classic narrator stating facts, viewer is given clues with camera work (substantive content) and montage (causation and relations). The cognitive input of audience’s own knowledge and assumptions become the core of interpretation of any produced filmed vision. The goal of the planned study is to research and demonstrate the nature of this assumed cooperation between the movie creator and the audience in an attempt to (re)create a coherent narrative from a blend of scenes. I hypothesize that process requires the knowledge of the medium, not only of the imitated reality as it has been previously described. A multi-level experiment is being developed which would hopefully give a better insight into the differences in audience’s cognitive approach depending only on the nature of provided information (fictional or real-life).

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## Rubber hand illusion does not arise from comparisons with internal body models



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Human body sense is surprisingly flexible – precisely administered multisensory stimulation may result in the illusion that an external object is part of one's body (e.g. as in rubber hand illusion). However, how exactly an external object and one's body koalesce into a single body representation remains unknown. There seems to be a general consensus that there are certain top-down constraints on which objects may be incorporated: in particular, to-be-embodied objects should be structurally similar to a visual representation stored in an internal body model for a shift in one's body image to occur. However, empirical evidence contradicts the body model hypothesis: the sense of ownership may be spread over objects strikingly distinct in morphology and structure (e.g., robotic arms or empty space) and direct empirical support for the theory is currently lacking. As an alternative, I propose a multisensory integration account of how the sense of ownership is induced. In this account, the perception of one's own body is a regular type of multisensory perception and multisensory integration processes are not only necessary but also sufficient for embodiment. The proposed model accounts for exceptional malleability of human body perception, fortifies existing bottom-up multisensory integration theories with top-down models of relatedness of sensory cues (Bayesian Coupling Priors), and generates testable and disambiguating predictions.

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## Sync To The Others Not To The Movement – The Investigation Into Shared Physiological Dynamics In Dance Improvisation



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A growing number of studies suggest that there is a crucial role for shared physiological dynamics in rapport, empathy, and in consequence in social coordination and team performance. This study investigates the presence and temporal development of shared interpersonal physiological dynamics of heart and breathing rates in dance improvisation. As a free, unplanned movement practice, group improvisation has the potential for dancers' physiological entrainment to appear, both through spontaneous synchronised movement, as well as empathic relation within the group. Firstly, we compared solo and group improvisation tasks, predicting that the group task will lead to higher coordination on a physiological level, measured by heart and breathing rate. Secondly, to differentiate between the two accounts of the mechanisms behind shared heart-rate and breathing dynamics (empathic facilitation vs coordinated movement), we took into account the dancer's activity level as an approximation of shared movement dynamics. As expected, group improvisation scores led to higher coordination on a physiological level in the group, measured by heart and breathing rate, in comparison to the solo task. Moreover, the comparison of the coordination of activity level showed that dancers were not in the higher movement (activity level) synchrony in the group tasks than in solo task. If coordinated movement facilitated shared physiological dynamics between dancers, the activity patterns would also be more coordinated in group tasks, and activity dynamics measures would be positive predictors of heart-rate and breathing dynamics. In this case, lower measures of activity coordination in the group tasks (in comparison to the solo task) suggested that empathic projection, the alignment of physiological states by aligning the emotional reaction to the situation, had facilitated the shared heart-rate and breathing dynamics within the group.

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## How similar are (visual) perception and (image) compression?



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independent

The use of regularities in the signal lays at heart of both biological and machine image-processing (Watson&Hull 1997; Nadenau 2000). One of the hotly contested points in the philosophy of perception is then the question of how the visual system processes information about the regularities in the environment (Geisler 2008), on which constructivists (e.g. inferentialists) disagree with bottom-up theorists (Embedded View, bayesians, Gibsonians; Orlandi 2014). Advances in digital image processing (e.g. Natural Scene Statistics; Torralba&Oliva 2003) and in computer vision (e.g. sparse coding, deep neural nets; Olshausen & Field 1996) challenged many of skeptics' concerns about what could be achieved by artificial (non-human) systems. This body of work seems to support the idea that at least the earlier steps of visual pathway can be explained more minimally than constructivists previously conceded. However, it remains unclear how the 'knowledge' of rules and regularities in visual processing ought to be conceptualized. Regularities enable compression (Dennett 2007), so the aim of this talk is to assess the usefulness of data compression as an explanatory model for (at least partly) explaining away this purported 'knowledge' or 'assumptions' (understood rather literally) essential for the interpretation of underdetermined stimuli. Similarly to the recent Daniel Wilkenfeld's (in press) argument on the nature of understanding, I will defend a position that compression as a maximization of 'output-to-scaffolding ratio' is a promising model of a successful cognitive performance also in visual perception. Furthermore, I argue that this constitutes an alternative account of rule-governed selective information-processing without resorting to the activity of higher cognitive faculties to interpret the signal.

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## What does it take to explain philosophical intuition? Some remarks on argumentative strategy of the “Sources project”

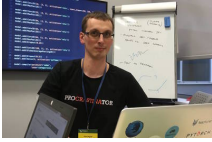
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In recent years a new approach in experimental philosophy called “the Sources Project” has emerged. Its aim is to identify psychological roots of certain philosophical intuitions commonly used in traditional philosophical debates and to explain them by showing how they are produced by well-known cognitive mechanisms. In doing so the researchers employ methods drawn from cognitive psychology, psycholinguistics and developmental psychology. The promise of this new approach is that knowledge of causal story of our philosophical intuitions can enable us to determine which of them are results of malfunction of our cognitive system and to classify them as some sort of cognitive illusion. In my talk I am going to systematize wide range of argumentative and explanatory strategies used in the Sources Project. First, I will present three examples of studies done in this line of research — employing theories from psycholinguistic research, developmental psychology and cognitive psychology. Next, I will show common elements of explanatory strategy used in presented works and major important differences between them. At the end I will indicate potential problems within the “sources project” concerning nature of explanations formulated by researchers working in this paradigm and propose possible solutions to most urgent of them. A secondary objective of my talk will be to introduce participants who are not familiar with developments in experimental philosophy to a new set of problems posed by recent additions to its methodology.

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## Drawing diagrams & thinking in tensors



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Typically we write equations as formulae. Yet, some operations make them long, cumbersome and prone to error (e.g. typos in indices). I will talk about drawing diagrams as a language for matrix-based mathematical operations. I will present examples from Feynman diagrams for particle physics, through Penrose graphical notation (useful in general relativity and quantum information) and causal diagrams in Bayesian statistic to deep learning architecture diagrams. I will show which properties become easier to discover, or become plainly obvious, once we turn equations into diagrams. I will follow with remarks on the usefulness of data-flow metaphors.

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## An action-based account of the false belief tasks



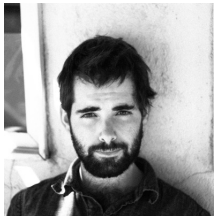
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In this paper, I will sketch an action-based account of children's performance on the elicited- and spontaneous-response false-belief tasks. First, I point out that traditional accounts (nativism, theory theory, and two systems), regardless of their consistency with the empirical data, are untenable on theoretical grounds; they commit to foundationalism about mental content (Bickhard & Terveen, 1995) and an inadequate concept of innateness (Oyama, 1985/2000). I will argue that an action-based account offers a way out of these theoretical problems as it models representational emergence and is consistent with the phenomena of development. My account draws mainly on interactivism (Bickhard, 2009; Campbell & Bickhard, 1986). According to the framework, children's performance on the spontaneous-response FBT is evidence of their level-1 interactive competence, which does not involve

explicit, reflective representation of mental states. In contrast, elicited-response FBT will require children to explicitly represent with the use of a level 2 some aspects of level-1 functioning (particular aspects represented can differ depending on the child's context of growth). The extent to which level-2 reflection is involved in the traditional FBT will be an object of debate, though. On the one hand, level-1 interactive competence gained in a linguistic context of development can be argued to suffice to pass the traditional FBT. On the other, the robustness of the results with preschoolers suggests a level-2 reflection, as does the empirical fact of the domain-general developmental milestone happening around age 4. The paper will end with a number of related questions.

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## Deep neural networks as a computational models of the human visual cortex



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The neural mechanisms of how visual information is encoded and processed by the human visual system remain weakly understood. Currently, there is not any computational model that satisfactorily explains visual perception. Furthermore, there is an intrinsic difficulty in testing computational models due to the different modalities of experimental data (EEG/MEG, fMRI, behavioural, etc.). Over the last five years, artificial deep neural networks (DNNs) have become widely adopted in the computer vision field due to their capacity to accomplish visual tasks with a similar performance to that of humans. This has led to the question: are deep neural networks plausible candidates as computational models of the visual cortex? Moreover, how do we test this hypothesis? For this, representational similarity analysis (Kriegeskorte et al., 2008) is a compelling analysis framework that allows us to evaluate candidate computational models against experimental data by means of characterizing the information in our data as a representational geometry. Within this framework information processing in the brain can be understood as an evolution of the representational similarity structure (Kriegeskorte et al., 2013). In this talk, I will review current DNNs vision models and discuss our experimental data (EEG, fMRI and behavioural) which

suggests that DNNs could explain some elements of how visual information is processed by the human visual cortex.

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## Coordinating quantifiers through language



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We present a preliminary work on the model of coordination of quantifiers by the community of communicating agents. Our model is a modification of the approach proposed [Steels and Belpaeme, 2005]. We restrict ourselves to quantifiers such as "the same amount", "less", "a little less", "much less", etc. The semantic representation of such expressions is based on a model of approximate perception of numerosity, known as the "approximate number system" (ANS) [Dehaene, 1997]. We introduce basic reactive units, which are intended to correspond to the ability to perceive the proportions of two quantities. Reactive units are the building blocks of more complex discrimination categories, which, as a result of adaptation processes taking place during communication, are linked to linguistic forms, which in turn may lead to the development of the lexicon of quantifiers common to all members of the community. We discuss a number of questions and problems related to monotonicity ("much less" implies "less") and the possibility of explaining it in the context of the presented model.

(collaboration with Nina Gierasimczuk and Dariusz Kalociński)

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## Addressing methodological gaps in HRV biofeedback research



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Recent fashion for holistic therapeutic approaches resulted in several research papers investigating the mechanisms and effects of this type of interventions. Biofeedback is one of such techniques under investigation, directed at voluntary improvement of physiological functioning of the body. One of the most robust and widely used psychophysiological markers is heart rate variability (HRV), therefore HRV levels became the basis of HRV-biofeedback (HRV-BFB) training. Nevertheless, despite many years of research the exact mode of action of HRV-BFB has not been pin-pointed yet. Similarly, there is no agreement with respect to the effectiveness of this technique as a form of therapy or treatment for somatic and mental disorders, as well as performance booster for healthy individuals. Investigation of the effects of HRV-BFB training is very likely hindered by several methodological problems of this field of research. The aim of this study was to tackle three significant problems: (1) lack of proper control condition for HRV-BFB training that would take into consideration the placebo effect, (2) no means to compare the subjects' perception of credibility of intervention and control group and (3) absence of an inclusion criterion for training quality assessment.

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## **PERI-vision: applying embodied and situated cognitive science to re-designing information pickup in visuomotor engagement for persons with age-related macular degeneration (ARMD)**



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Embodied and situated approaches in cognitive sciences have 1) pressed information processing into the service of sensorimotor control of action and 2) embedded it in the socio-cultural environment. Here I explore reading and writing, *prima facie* cultural skills for sharing and picking up information. Using live demonstrations based on a pupil lab's eye tracker (Kassner et al. 2014), I first illustrate basic eye movement strategies in reading – systematically scanning a visual scene with central vision. Through a gaze-contingent moving window paradigm we simulate a severe and widespread visual disability, age-related macular degeneration (ARMD) which progressively leads to loss of central vision (Rayner 2014). I then illustrate the approach taken by current intervention techniques: re-adapting the person to fit the environment by means of magnifying glasses and even painstaking re-learning of a personalized novel eye movement strategy based on mapping the extent of retinal lesions (Nilsson et al. 2003). Finally, I contrast this approach with PERI (Peripherally Enhanced Redundant Information), a project in progress aimed at redesigning the visual world of a person with ARMD to fit their previously established gaze strategies. I will conclude with a reflection on how we have designed our cultural environments to match our sensorimotor engagements (Dehaene 2009), and invite a re-imagining and redesigning of our cultural world, in particular to better match the needs of persons with atypical forms of engagement, here visual deficits caused by ARMD.

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## **Spatial purport of perception. Modelling first-person, subjective experiences with predictive processing**

WR

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Egocentric spatial representations have a very specific "what it is like"-ness. Those subjective and phenomenal aspects of perceptual experiences have been termed "spatial purport of perception" by Rick Grush, who attempted to develop their computational model. Although the model is interesting, his work lacks a clear definition of what this "spatial purport of perception" is. What is more, there is a large class of experiences related to perception of object motion, movements uncaused by the subject, that he fails to adequately describe. In my presentation I will try to fill those gaps. First, I will try to provide a proper definition of this "spatial purport of perception", that covers its both qualitative and quantitative aspects. Second, I will try to show how the insights from predictive processing help us develop Grush's original model into a more precise model of "spatial purport".

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## **Exploring the roles and interplay of different modalities and strands of action in the co-composition and co-regulation of joint cultural activities**



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This is an invitation to a joint exploration of the co-composition of interaction: we start by looking at a video-example of everyday infant-caregiver activities, as it pushes us beyond our familiar adult conceptual frame biased towards language and reasoning and the model of "serial information processing" inspired by it, and opens up a view on the richness and intricate complexity of

the – fundamentally dynamic, multi-modal, and multi-strand – co-composition and orchestration of joint activities. While many aspects of co-ordination have been studied in isolation in different fields, we as of yet lack systematic research and knowledge about the different functional roles different modalities and action-strands play in the co-regulation of natural(istic) interaction in accordance with their respective functional characteristics. Bringing together approaches from the socio-cultural as well as from the biological sciences, I would like to invite you to join in a “sensory ecology of culturally shaped human activities” and – first drawing on the mother-infant interaction episode and continuing with our own live ongoing interaction experiences at the conference – jointly explore: What are the distinct functional characteristics of the different sensory modalities and action-strands involved in interaction, what are their complementary functional roles to sustain and co-regulate interaction, and, crucially, how does their interplay enable participants to allocate action-resources to, integrate and co-ordinate different parts of the activity involving different partners and targets of action and link different time-scales?

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## Designing Networks of Spiking Neurons for Practical Use: the Case of Reading



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The current iteration of artificial neural networks research focuses on models far removed from biological knowledge, to the point of almost complete mathematical conventionalization. However, there exists a trend of simulating so-called spiking networks using neural models of varying levels of simplification. It is an area tightly connected to empirical neuroscience, but working with packages for simulating of neurons in software, such as NEST. I describe some ways in which we can try to construct models that process information in ways that are interpretable and analogous to known biology. I use an example of dual-route reading model from neuroscience. It is a model giving us a simple, interpretable structure for a neural network and could be

used practically for automatic error correction. The continuous and strictly electrical mode of operation of biologically-plausible neurons forces on us specific ways of discerning and sustaining information, in short as well as in long term. How biological systems can perform many of these functions is still not known. What biological constraints, easily eliminated from traditional artificial networks, could tell us about animal cognition is also an open question.

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## Rituals as a consequence of external information



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Looking at social or cultural behavior of different groups of people, we notice the extraordinary richness and diversity of the ritualistic behavior that surrounds us, for example gestures of sportsmen (such as the series of Rafael Nadal's rituals or hitting the starting bar before jumping by Adam Małysz), way of mixing the dough by our grandmothers („one way only, because it will fall off”), and finally behavior during the celebration of religious rites. It is worth noting, that – regardless of the origin or place of residence of people performing rituals – they have many common features, in particular, they are carried out according to the assumed scenario, they are repetitive, they are characterized by rigidity, and the activities performed are not used to obtain measurable effects. And it seems that it should not be surprising, as human minds are similar to each other throughout the species. To understand the nature of rituals and the basic issues associated with them, research based on a functionalist approach to the ritual in Malinowski's theory was planned (he wrote that the practice of every ceremony or ritual important for society is strictly defined by means of a description of the specific activities to be performed), which are designed to bring us closer to answering the question about the mental cause of the universality of rituals and how it happens that intentional and repetitive human behavior begins to spontaneously evolve into them. Using a research tool specially created for the needs of this research – a simple computer game in which the participant is to bring a token to a specific place – pilot studies under the direction of prof. Konrad W. Talmont-Kamiński at the Institute of Sociology and Cognitive Science

at the Faculty of History and Sociology at the University of Białystok were carried out. I would like to present the results of these studies and subject them to critical analysis.

Literature:

Malinowski, B. (1925). Magic, science and religion.

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## Understanding the role of plasma membrane curvature in cell motility



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Cell motility is a beautiful manifestation of biological self-organization upon environmental changes. Several individual molecules need to be finely tuned in space and time to govern large-scale coordination and polarization of the motility apparatus. Recent studies emphasize the importance of mechanical properties, such as plasma membrane tension, as a global integrator of multiple cellular behaviors, including cell shape and movement. The plasma membrane tension may be a particularly useful conduit for transmitting information, as propagation of its changes affects almost instantaneously the entire membrane, acting on a much faster timescale than reaction-diffusion systems. Despite plasma membrane tension importance in a plethora of cellular processes, it remains unclear how cells are sensing this mechanical property. We hypothesize that changes in membrane tension affect the landscape of plasma membrane deformations, also referred to as membrane curvature. This could, in turn, alter the binding of membrane proteins.

Currently, we are investigating one group of proteins (BAR domain family), focusing on the interplay between membrane tension and curvature binding.

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## What do we read during mindreading?



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One of the aspects of our social life is an attempt to understand others. We try to perceive and analyse others' intentions, beliefs and emotions. In philosophy and cognitive science we call an ability of ascribing mental states: mindreading or mentalizing. In my presentation I will present two aspects of the philosophical debates on mindreading: different types of modelling this process and the types of mental states which are mentioned in these theories. When presenting theories of mindreading (theory theory, simulation theory, person model theory, interaction theory) I will focus on the question: what kind of mental states are presented in each theory. I will then question their scope of application when describing the mental states ascription. In this context I will present the work of Fonagy and Luyten in which they introduced the theory of mentalization based on analysis on personality disorders. They presented this ability on four dimensions: implicit-explicit, internal-external, cognitive-affective and self-other focused. I will then present how their point of view can enrich philosophical theories and vice versa, especially in the subject of the presentation: the question about types of mental states which are ascribed during mindreading. My presentation will not exhaust the topic, but is about to shed a new light on the question: what do we read during mindreading process?

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## Towards a model of interaction after laryngectomy. First person perspective on selected communication methods



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Laryngectomy (removal of the larynx) is a surgical treatment of laryngeal cancer, that leads to voice loss. The most intuitive approach to tackle this issue is to restore one's voice that is assessed by listeners as the most intelligible and natural in listening tests. However, human communication is not just about transmitting "the piece of information" from speaker to the listener in the most efficient way. The way how the speech content is transferred (e.g. intonation, accompanying gestures, mimicry) and the context of situation plays a crucial role in social communication (e.g. transferring emotions, showing personality and maintaining relationships).

During the half-year period after my laryngectomy I had used different ways of communication (often very untypical ones). I will show what I learnt about communication from watchful observation of my everyday life during that period. Those insights do not fit voice restoration approach, but yet phenomena observed seem to play a role in the communication process. In order to better understand interactions after laryngectomy I propose a model with 3 systems involved: the patient, artificial system (e.g. electrolarynx) and interlocutor(s), each of them having some computing power and potential to learn.

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## Emergent patterns of coordination – relation between turn-taking structure and content of communication in group interaction



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Turn-taking, the orderly succession of speakers taking the floor, may be considered one of the basic manifestations of synchronization in group interaction. The existing literature on turn-taking in group interaction is dominated by work on the structure of participation, i.e. how much group members speak during interaction and why they differ in their propensity to speak. Much less is known about the structure of turn-taking sequences, i.e. why and when group members speak in a particular order. The goal of the presented research is linking structural properties of turn-taking in group conversations, i.e. sequential patterns of turn-taking to a) content of verbal exchanges and b) situational context of group interaction. We posit that patterns of turn-taking are indicators of momentarily established coordination, oriented at a realization of a specific collective action. Coordination emerges as a patterned sequence of individual behaviors in a bottom-up fashion, however, it also has its own autonomous dynamics, or “grammar”, that reorients individual behaviors in a top-down manner. The presentation will begin with the summary of past research and end with a glimpse into the future research plans. Results of 2 studies will be presented, conducted on both live and online group discussions, in which we measured turn-taking patterns emerging spontaneously between consecutive speakers. Basing solely on turn-taking structure we were able to distinguish disagreeing from agreeing groups, identify moments of elevated group conflict and predict mutual peer-to-peer ratings of group members. In the last part of the presentation, the future research program will be presented which aims at identifying turn-taking patterns characteristic for discussions on different topics and for groups performing various goals.

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## Ten reasons why social interactions are more than just any physical interactions



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Social interactions are physical in the sense that they rely on physical mediums—e.g., voice manifested as acoustic wave—and that participants of those interactions, as biological organisms, are physical. Yet in our experience interacting with other human beings is very different from interacting with inanimate matter. It is easy to argue that social interactions are special in many ways, and require specialized cognitive skills. I attempt to discern those special characteristics starting from the most basic principles. I tackle many topics often discussed in the field of complex systems: complexity, historicity, autonomy, goal-directedness, multiscale organization. Then, I draw a picture of social interactions as being distinct, but at the same time sharing specific properties with many other types of interactions. From this perspective I consider mainstream theories of social cognition which refer to hidden mental states, such as various accounts of theory of mind. I discuss the meaning of those hidden states, and argue why modeling them may be an effective cognitive strategy for managing social interactions.

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# Posters, demonstrations & reviews

## Mere Exposure Effect in visual – haptic perception



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Mere Exposure Effect is one of the best known psychological phenomenon. Since it was described by Robert Zajonc in 1968, the research area has remained dominated by studies in isolated visual and auditory modalities, which were remote from the conditions of the natural environment. This work propose to complete this deficiency by adumbrating a new model of experiment, which might allow to win conclusions concerning the Mere Exposure Effect in nonlaboratory conditions. For this purpose, the visual-haptic non-attentional stimuli were used, and the measurement were made within EEG methods. As a result of a pilot research, we obtained expected decrease of gamma oscillations, which is interpreted as a correlate of higher preference occurring typically in Mere Exposure Effect, and unexpected differences in beta oscillations. Analysis of declarative ratings did not show differences which might be interpreted as an evidence of Mere Exposure Effect. In discussion, we consider possible reasons of ERSP changes, as well as variance with declarative data. Additionally, conclusions concerning procedure's refinement enables to explore accurate researches in Mere Exposure Effect in visual – haptic perception.

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## Temporal organization of action observation and complex mental attribution: an event-related potential study



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The neural correlates of social information processing are the focus of widespread research interest. While the spatial organization of social brain networks has been extensively studied, little is known about the temporal organization of social cognitive processes. Theory of Mind is the ability to understand mental states of other people, which involves observation of that person's appearance and actions. Here, we investigated event-related potentials (ERPs) in 30 healthy individuals in order to compare the time course of action observation (AO) and complex mental attribution processes (ToM). Photographs of naturalistic human behaviours, which contained either people or hands were presented. The participant answered 'yes' or 'no' to questions designed to focus their attention on why (ToM) the action is performed or how (AO). In line with previous observations, faces elicited larger negativity in the occipitotemporal areas 250 ms poststimulus than hands. However, up until 600 ms poststimulus presentation, no impact of the task type (AO vs ToM) was observed. AO condition evoked more positivity over central regions than ToM between 600 and 1000 ms poststimulus presentation. Task type effects were observed only in the late stages of stimuli processing, thus complex mental attribution might rely on the processing performed during action observation. Given those results are preliminary, more investigation is needed to confirm this hypothesis.

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## The description – experience gap in the research of social decision making



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According to the prospect theory, decisions under risk (with a provided description of possible outcomes and probabilities of obtaining them) could be characterized with the fourfold pattern of behavior [1]. Specifically, people are risk-seeking for low probability events in the domain of gains and for high probability events in the domain of losses, while they tend to be risk averse for low probability events in the domain of losses and for high probability events in the domain of gains. These considerations indicate that rare events are perceived as more probable to occur than objectively probabilities state. Interestingly, this fourfold pattern of behavior is reversed in the case of decisions from experience where people do not have information about the distribution of outcomes associated with different options [2]. This difference is known as the description-experience gap [3]. Recently, there were several attempts of examining whether this effect occurs in the social context (e.g., [4]). The aim of this presentation is to discuss recent theoretical background regarding these issues and to present a plan of own research to be conducted in the future.

Supported by the Ministry of Science and Higher Education of Poland, Diamond Grant, decision number: 0135/DIA/2017/46.

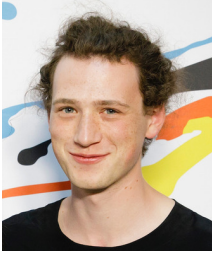
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## The boundary of mind under predictive processing



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Predictive Processing (PP) is a framework aiming to explain how the brain works. It has gained significant prominence in recent years in both neuro- and cognitive science as well as philosophy. This theory aims to explain cognition, perception and action by a single simple principle: all the brain does is predicting its incoming sensory signal. Assuming PP, what is part of the mind and what is not? In other words: where does the boundary of the mind lie? Is the mind simply located in the brain? Or does it also encompass parts of the body and the world? Or does the brain have no special place at all and the mind is closely linked to the survival of a creature? I offer a taxonomy of predictive processing approaches in philosophy: conservative predictive processing (CPP), which emphasises the notion of a model, radical predictive processing (RPP), which, despite its name, is a compromise marrying an inferential perspective with an emphasis of the importance of action and cheap embodied strategies and enactive predictive processing (EPP), which rejects talk of inference and emphasises the free energy principle to reconcile the predictive brain with enactivist intuitions such as the life-mind continuity hypothesis. I then analyse the different conceptions of the boundary of mind under the three perspectives, and, building on that, how the PP framework constrains the positions one can take regarding the boundaries of the mind and, on the flip-side, where it leaves space for philosophical debate.

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## MovEye: Simultaneous gaze control of multiple parameters



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MovEye is the Windows application for watching and controlling video streamed from YouTube service. It allows the disabled people to control the movie playback by gaze in multiple ways. The application is currently under development, but we have first results of user experience tests. The aim of the project is to improve and adjust the video playback gaze control methods and to develop the new ones. To our knowledge, it was not the subject of the systematic study, yet. Therefore it is not only important from practical point of view (as stimuli provider with possibility of its control), but also from scientific one. In addition several other projects developed in our lab will be discussed, including the innovative gaze keyboards and the gaze data analysis toolbox.

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## Looking for grounding – semiotic behavior in “The Symbolic Species” by T. Deacon (review)



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I chose Terrence Deacon's “The Symbolic Species” because I am interested in the conceptual and historical grounding of semiotic abilities. When considering descriptions of language abilities in humans, there is a considerably large number of strong arguments supporting an approach which could broadly be called Chomskian or generative. In this understanding, the human language

ability can reasonably be considered not as “a skill among many”, like flying a plane or playing checkers, but as a very specific skill for the utilization of which our framework is somehow designed. But even though this paradigm still proves fertile, especially in linguistics, it falls short of providing convincing explanations of some phenomena connected to language, but falling outside the field of formal linguistics, such as evolutionary issues, social and conceptual development (as in the work of Vygotsky) or animal communication (as invoked by Deacon in the preface to his book). Here, one could treat the more recent research interests of Ray Jackendoff aiming at integrating elements of cognitive semantics and social cognition into the generative paradigm as indicative of these shortcomings. On the other hand, the generative approach, as fruitful as it is, might be narrowed down and treated in a much more methodologically instrumental rather than realistic manner. Then, the question of the philosophically or cognitively considered basis of language ability or semiotic behavior might be considered re-opened. In this scenario, numerous questions and assertions made in “The Symbolic Species” might prove very pertinent.

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## **Comparing the effects of HRV biofeedback and novel sham control condition on chosen psychophysiological measures**



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In the effort to assess the credibility of our newly designed sham heart rate variability biofeedback (HRV-BFB) protocol as a potential control condition for HRV-BFB training we decided to compare the effects of these two types of intervention on chosen psychophysiological measures previously reported in literature to be affected by HRV-BFB. 61 healthy individuals (age 18-35; mean =  $22.38 \pm 3.27$ ) were semi-randomly divided into two groups: HRV-BFB (N = 28) and sham HRV-BFB (N = 33). Both groups underwent 20 training sessions preceded by pretest and followed by posttest during which ECG and psychometric data was gathered. The pulse plethysmographic signal collected during the session allowed to calculate the Yield Efficiency of

Training Index to assess the quality of training in both groups. Baseline levels of HRV were further used to investigate, whether subjects with low/high initial HRV respond differently to the training.

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## Evaluating the scalability of deep active inference



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Active inference is a modeling framework in computational neuroscience build upon the assumption that cognitive systems encode a hierarchical generative model of the world and act as to minimize their prediction errors. Both perception, learning and action can be cast as Bayesian variational inference, i.e. gradient descent on free energy, which imposes an upper bound on prediction error. Since active inference, while being theoretically principled, can account for a variety of neurophysiological, clinical and behavioral phenomena, it is frequently seen as a formal model of cognition in general. Existing implementations of active inference, however, are poorly comparable to alternative models and fall short of meeting reproducibility standards. Moreover, these simulations are usually limited to toy environments, which casts a shadow of doubt on whether active inference scales up to complex cognitive systems in the wild. The goal of the project is to develop a universal active inference controller from scratch based on recent advances in scaling up variational inference models by coupling them with deep neural networks. The controller will be evaluated against state-of-the-art reinforcement-learning algorithms in several Atari environments (a received benchmark in machine learning).

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## “Thinking fast and slow” by D. Kahneman (review)



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I chose this book because it concerns many aspects of human perception. Kahneman touches upon the topics of Behavioral Economics and rationality, proposes a new concept instead of utility theory, talks about happiness, well-being, and their measurement. This book is written by a psychologist, interested in the driving forces of human behavior. One of the best creative work that helps the public understanding of topics in behavioral science, engineering and medicine

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## Explainable AI



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More and more decisions are made by machine learning algorithms. These algorithms often make very good decisions, but we don't really understand why. They are essentially blackboxes. In order to integrate machine made decisions into human decision making processes, the algorithm needs to be able to explain its decisions in a way that generates trust and understanding in humans. I will talk about what constitutes an explanation that's accepted by humans and then show several methods currently in use to help interpret machine learning models, like counterfactual examples, influence functions and LIME.

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## Proprioceptive accuracy does not modulate the strength of the rubber hand illusion

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Rubber Hand Illusion (RHI) results from spatiotemporally congruent visuotactile stimulation which induces a sense of ownership over a fake limb. Yet, the role of proprioceptive information in the formation of the illusion remains unclear. Even though proprioception was indicated to constrain the window of visuotactile integration, the influence of online proprioceptive signals on RHI seems to be limited. For example, it has been shown that mechanical displacement of participant's hand during elicitation of the illusion (either towards or contrariwise to the rubber hand) does not influence the strength of the illusion. To examine the role of proprioceptive signals in RHI, we displaced participant's hand from the starting position (16cm between hands) either to the position close to (8cm) or far from (24cm) the rubber hand without the participant noticing. Prior to the experimental manipulation, we measured proprioceptive abilities in a task requiring active reproduction of the arm's position. We were particularly interested in proprioceptive accuracy (operationalized as a mean absolute difference between target and reproduced positions) and precision (inverse variance of reproduction errors). We predicted that precise proprioceptive signals should entail narrowed spatial window of visuotactile integration, resulting in attenuated illusion in the "far" but not in the "close" condition. Multiple regression analysis showed that neither proprioceptive accuracy nor precision were predictors of the illusion strength. The interactions between accuracy/precision and experimental condition (far/close) were not significant as well. Bayesian Factor analyses proved that our results reflect genuine null effects rather than experimental insensitivity. Additionally, we found that proprioceptive accuracy and precision were very highly correlated which may question the need for the distinction between these two dimensions. In sum, our results show that online proprioceptive signals, pertaining to the exact localization of the hand within peripersonal space, are not relevant for multisensory integration processes giving rise to Rubber Hand Illusion.

## Cognitive load theory in e-learning: what can increase people's motivation to study from home?



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Cognitive load theory suggests that effective instructional material facilitates learning by directing cognitive resources towards activities that are relevant to acquisition of every special part of information. According to the cognitive load theory, the limitations of short-term memory exert a strong influence on learner's ability to process information. The study of this special issue can provide designers of e-courses with additional tips, which help to encourage learners to study from home and optimize their intellectual performance.

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## Soft telerobots as mediators between humans (demo)



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In a world that is increasingly virtual, we are being fed with reduced and partial information about our social neighbors. The gap that we are left with is a growth medium for prejudice, dehumanization and fetishism of figures. A large-scale technological solution is needed in order to mitigate the fast circulation of prejudice in society. Remote controlled robots could serve as mediators and create encounters between different layers of society. They are able to cross borders and bridge over language barriers, while still maintaining a direct, intercorporeal experience. Soft robots in particular are a good candidate for such interactions since they move organically and are soft to the human touch. The phenomenology of Merleau-Ponty suggests that a 'fleshy' encounter with the Other is required for a true openness into

our social reality. This is backed by neuroscience research describing the brain as a dissipative system. A case study for soft telepresence is presented: HITODAMA, a soft avatar designed to be a neutral re-embodiment for the dissolution of prejudice. Its form is inspired by the Japanese symbol for the human spirit and the immortal Mexican salamander Axolotl. In the talk I will discuss about the process of making HITODAMA and the events that led to its conception.

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## Novel speech restoration and augmentation system

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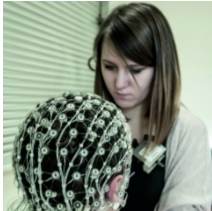
Speech can be seen as the most direct means of interpersonal communication. The physiological process of speech production can be divided into two sequential stages: phonation and articulation. The phonation process depends on the activity of the larynx. In case the organ is removed (laryngectomy) as consequence of a disease, most commonly laryngeal cancer, the affected person is thus severely impaired in the ability to speak. There exists methods to compensate the loss of voicing either by physiological means, surgical operation or use of external source of voice (electrolarynx). However, all of those methods are cumbersome and impart distortions in both the segmental and suprasegmental elements of the spoken language (Tang and Sinclair, 2015). New technologies addressing those issues are developed, which can be summarized into following categories:

- 1) improvements in the electrolarynx device 1.1) remote control (Fuchs 2016, Goldstein et al. 2004, Heaton 2011, Huber 2016) 1.2) enhanced pitch control (Ahmadi et al. 2014, Matsunaga et al. 2011) 1.3) use of electromyography (EMG) (Ahmadi et al. 2014, Heaton 2011, Huber 2016)
- 2) voice conversion techniques (acoustic signal enhancement) (Janke et al. 2014, Li et al. 2013, Sharifzadeh et al. 2010)
- 3) personal voiceprint creation for speech synthesis (Garrido et al. 2008, Yamagishi et al. 2012)
- 4) novel biocybernetic systems (Ahmadi et al. 2018) The integration and optimization of aforementioned technologies leads to a new design of a system

consisting of remotely controlled electrolarynx, speech amplifier and a mobile application with personalised voice.

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## Effectiveness of different types of language training in infants



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The most effective way of acquiring any language is observed in infants. Unfortunately, discrimination of the foreign language sounds decreases after infants reach the eighth month and transform into preference of mother tongue (Kuhl, 2010). It was proven that so-called sensitive period can be extended with early language intervention with native speaker (Rivera-Gaxiola et al., 2005). These results inspired the question whether this relationship occurs only in the condition of the training with a native speaker or interaction without social component can prolong this ability as well. To capture similar changes in the Polish infants we created diagnostic procedure based on anticipatory eye movement paradigm with recordings of pseudo-words differing in the French vowel phonetic contrast. The study involved 60 infants aged from 8 to 12 months whose only language used at home was Polish. In addition, children younger than 10 months were assigned to three training groups: native, passive and interactive in order to check the effectiveness of particular condition. As in Kuhl's studies, training series consisted of 12 meetings lasting 20 minutes each (e.g. Kuhl, 2011). Gaze controlled animation was created as an interactive training. Infants could activate particular scenes by looking at chosen characters from Peppa Pig, who then started short talks in French. An interactive animation condition seems to be the most effective type of training. Comparison between types of training shows that native speaker training maintain the ability to differentiate subtle French vowels as well as the passive one. Results indicate that interactions are more attractive for infants and crucial for early language development.

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## Perceptual priors on tactile rhythms in the deaf (demo)



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If born and grown up in the Western culture you would probably feel strange when synchronise or dance to amazonian music. Recent study on perceptual priors show how the preference for certain rhythmical patterns differ across cultures (i.e Bolivians and Americans) Authors suggest that shared rhythmical patterns are shaped simply by common musical exposure. However rhythms perception has its importance outside musical or auditory experience (in movement, visual communication, gestures) It remains questionable though if music is crucial for a culture to acquire shared rhythms representations. Here we explore the probability distributions (priors) for rhythms developed in a culture without any exposure to (auditory) music. We recruited group of congenitally deaf subjects and group hearing controls. The study paradigm consist of an extension of the game of “broken telephone” used to reveal priors in the domain of language. During the experiment, tactile rhythms are delivered on the participants’ torso (using strip designed to feel the beat throughout the body). Participants are asked to tap and reproduce random “seed” rhythm, their reproductions is fed back as the stimulus, and over time became dominated by internal biases, such that the prior could be estimated. Preliminary results suggest that rhythmical representations developed in deaf differ from those already identified as typical to the Western culture. Deaf subjects tend however to share interculturally identified bias toward producing rhythms composed of integer ratios. I will show some pilot results, but still would like to receive some feedback about the study design. (project collaborators: Nori Jacoby, Columbia University, Josh McDermott, MIT)

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