

## Keynote talks

**Dor Abrahamson**

*University of California Berkeley*

### **Tightening Our Grip on Attentional Anchors: In Search of a Common Cognitive Source of Functional and Semiotic Actions**

A retrospective comparison of two embodied design genres for mathematics education focalizes similarity and difference in the cognitive roles that perception plays in each. In both genres perception enables students to promote their task performance, and ultimately their conceptual learning, by guiding a new action-oriented grip on features of the environment, and in both genres this new capacity is achieved through sensorimotor exploration, whether covert or overt. However, the genres differ with respect to the learner's self-criteria for evaluating the conceptually critical sensorimotor invariance of their perceptual grip. These criteria are either: (1) a felt sense of a target aspect in a source phenomenon — learners attempt to evoke the same felt sense as they perceive a new stimulus proposed as a mathematical model of the source phenomenon; or (2) an external technologically enabled feedback on the quality of learners' dynamic action form as measured against a mathematical ideal. The two design genres thus both promote conceptual learning through sensorimotor development of cognitive structures, yet they differ in the epistemic function of this cognitive activity as measured against either internal or external criteria. In turn, whereas the internal criterion supports a "semiotic leap" (accepting the new stimulus as an analytic model of the key aspect in the source phenomenon), the external criterion supports the functional effect of motor action. The paper aims to advance the theorization and implementation of embodied design.

**Łukasz Dębowski**

*Institute of Computer Science, Polish Academy of Sciences*

### **On the Process of Becoming a Mathematician: A Personal Account**

I will talk about my personal path of becoming an applied mathematician. I will focus on my motivations, concerns, and challenges.

**Magdalena Kersting**

*University of Copenhagen*

### **Figures of Thought, Figures of Action: An Embodied and Enactive Exploration of Metaphors in the Instructional Practices of Science Teachers**

Educational research has a long tradition of examining the role of metaphors in teaching and learning science. However, much of the existing research has narrowly focused on verbal manifestations, thereby failing to acknowledge the rich, non-verbal dimensions metaphors can assume in instructional contexts.

In this talk, I will first present a study integrating perspectives from embodied cognition, enactivism, and the social semiotic theory of multimodality to explore how five middle school science teachers used metaphors in their speech, gestures, and other embodied modes during authentic lessons. We found a prevalent use of metaphors primarily during the introduction of new, abstract concepts and the

explanation of complex phenomena. These metaphors were often expressed multimodally, where teachers utilized gestures, drawings, and material objects to cue the source domains.

We identified distinct patterns where enactment and modelling gestures initially communicated the metaphorical meaning before teachers transitioned to oral and more abstract representations. Some teachers established sustained use of gestures to maintain metaphoricity over time.

These results illustrate that metaphorical performance in science teaching is a dynamic, embodied, and enacted process. I argue that a deeper understanding of the dual function of metaphors - as figures of thought and figures of action - can significantly enhance instructional practices in science education.

I will then use this study as an illustrative case to reflect on the role of the body and embodiment in science education more broadly. By contrasting these findings with practices in mathematics education, I wish to explore how movement patterns and embodied gestures serve as cognitive tools across disciplines, reinforcing the idea that patterns of movement often underpin patterns of thought. In doing so, I aim to offer interdisciplinary connections, building bridges between educational research and fields such as psychology and cognitive science.

### **Contributed talks**

**Anna Alińska**

*University of Warsaw*

#### **The Interplay of Movement and Thought in (Artificial) Social Systems**

This work explores how patterns of movement and thought co-evolve within a computational model of socially motivated agents. The agents, equipped with a Model of Other Agents (MOA) module simulate their potential movements (or messages) to determine the actions most likely to influence their peers, seeking out patterns that maximise their influence on others. This dynamic interdependence highlights the reciprocal nature of (even artificial!) thought and movement in social contexts, as the agents' predictions (thought) drive their physical behaviour, which in turn refines their predictions. Although lacking physical embodiment, artificial agents can still offer valuable insights into how cognitive and physical dynamics co-create complex social behaviours in both artificial and biological systems.

**Weronika Bagniewska**

*Philosophy Department, Cognitive Science*

#### **ESI - app for students helping with learning with AI and gamification**

ESI won first place award and public award in the last Brave Camp competition. It is app for students who uses tablets and study human, social or medical sciences. In ESI we make a note, then in the best time using method spaced repetition, we get notification with AI generated quiz based on our notes. When we make our quiz, we gain points, and we are building with these points a titular robot ESI. I will present an app idea and talk about the work we do as an ESI team.

**Bibianna Bałaj**

*Institute of Psychology, Faculty of Philosophy and Social Sciences, Nicolaus Copernicus University in Toruń*

### **Patterns of eye movements in the perception of abstract art**

The necessary condition for perceiving the beauty of an artistic product is the personal experience of this beauty. Differences in aesthetic perception depend on who the author of a given work is and what we know about it.

Visual scanning is the first stage in creating an aesthetic experience. Selective arousal of attention by selected attributes of the image (e.g. color, shape) shapes the aesthetic experience.

We investigate how the artist's intention (high-level feature) and physical features (using objective measures of complexity: statistical image properties, SIP) of the image (low-level feature) affect the perception of abstract work.

The first conclusions from our research indicate that for subsequent exposures, regardless of the author of the work of art, local scanning changes into global scanning. Interestingly, the lower the coherence (a low-level feature of the image), the higher the aesthetic experience.

**Katarzyna Chyl-Tanaś**

*Instytut Badań Edukacyjnych*

### **Understanding Adult Literacy Gaps in Poland: A Data-Driven Approach to Predicting Low Reading Proficiency**

In adults, low reading proficiency can be associated with economic, legal, and health-related consequences. According to the 2012 PIAAC survey, this issue affects nearly one in five adults in Poland. Such individuals may struggle to comprehend even simple texts written in everyday language. Despite this, there is still a lack of effective diagnostic methods that would allow for a better description of this phenomenon, its examination, and the subsequent introduction of effective interventions. This article presents a reanalysis of PIAAC data aimed at selecting the most predictive background questionnaire items for reading proficiency. It then describes a study in which adults of varying ages and educational levels (N = 400) completed a reading comprehension test and answered questions regarding demographic characteristics, living conditions, and habits related to reading. The regression model showed that lower educational levels, a low number of books at home at 14, a reported need for assistance with reading medical materials, and a self-assessed low reading proficiency accounted for a significant portion of the variance in the model and were associated with lower reading scores. An additional model, which included questions about work tasks among employers (N = 246), also indicated that performing physical work was associated with lower scores. The proposed questions may serve as a basis for creating a questionnaire to help identify adults at risk of reading difficulties. At the same time, they cannot replace a performance-based test that directly measures the practical application of reading skills.

**Anna Czartoszewska**

*Cognitive Science, Psychology Department, University of Warsaw*

### **Initial Insights into Player Behavior at the ORTHO Exhibit**

Using technology in education gives us an opportunity to aid learning in a non-traditional and entertaining way, as well as provides data to gain insights into the learning process. ORTHO, an interactive tabletop digital exhibit located in the Copernicus Science Centre (CSC) in Warsaw, introduces users to the Cartesian coordinate system through a two-player game, where each player controls either the x- or y-coordinate. There are 3 difficulty levels, each with a few tracks.

In my work I conducted initial exploration and analysis of the data gathered over 30 days, comprising 18613 trials. The goal was to examine how players' behavior differs across successful and unsuccessful trials, difficulty levels, tracks, and the type of players' companionship. Visualization of the trial trajectories gave insights about the paths chosen by participants. Moreover, I compared trial times, overall game times, times for a single track, and completion rates.

Preliminary findings suggest that the current difficulty classification may not align with actual player performance. Furthermore, although many statistical comparisons revealed significant differences, the effect sizes were generally small (e.g.,  $\eta^2 = 0.06$ ). One of the observations from this data exploration is that the data collected in uncontrolled conditions is very noisy and contains a lot of erroneous information. A careful data cleaning process will be required before conducting a full analysis, which was not completed here due to time constraints. Another limitation of this work is the intuitive nature of my decisions, which ideally should be based on existing literature.

**Agnieszka Debska**

*The Nencki Institute of Experimental Biology*

### **Neural Correlates of Abstract Symbol Processing: A Semiotic Approach Using Artificial Orthography Learning in fMRI**

The study investigated neural correlates underlying the processing of abstract linguistic symbols using C.S. Peirce's semiotic framework. In the functional magnetic resonance imaging session (fMRI) we tested 40 Polish adults (mean age = 21.38, SD = 2.34; 20 male, 20 female). We designed an artificial orthography learning task with six types of abstract shapes and unfamiliar speech sounds. They were first presented in a single modality (classified as icons), followed by icons of both modalities presented simultaneously (classified as indexes). Finally, the stimuli of both modalities were presented simultaneously with a set of predefined orthographic rules (what was classified as symbols). After scanning, participants took a test to assess how well they learned the auditory-visual combinations and arbitrary rules. During the presentation we will show the results on the whole-brain and regions of interest levels of activity, focusing on processing of newly learned linguistic associations in relation to the functional changes in the language network.

**Ilona Howiecka-Tańska**

*Centrum Nauki Kopernik*

### **ORTHO: what is this case of?**

The ORTHO exhibit introduces users the Cartesian principles of representing numerical data as points in a two-dimensional space—the coordinate system.

An action-based embodied design, ORTHO draws on: the enactivist tenet that individuals' cognitive structures emerge from recurring task-effective sensorimotor patterns discovered through explorative perceptuomotor activity; and cognitive-anthropological theorizations of shared ontologies as emerging through multimodal social interaction to facilitate the coordinated enactment of joint action.

The proposed session is a workshop during which participants will become familiar with the principles of ORTHO and respond to the Data-Analysis Discussion Points.

**Witold Kraszewski**

University of Warsaw

### **Rolling with the Rhythm: Classroom Mobility and Heart Rate Synchrony in Learning**

In class, teachers aim to connect with their students in order to effectively pass on knowledge and skills. Alongside the flow of information and ideas, physiological synchrony often occurs—here, measured by changes in heart rate. This synchrony could indicate deeper levels of engagement and interaction between students and their teacher.

The primary goal of this study was to examine whether new, mobile classroom furniture could enhance cooperation and communication in the learning environment. A secondary objective was to conduct a pilot study on heart rate synchrony during school lessons. In the experiment, 20 classes of around 15 primary school students each attended 45-minute lessons on two separate days. Ten classes were selected for heart rate monitoring, where the teacher and nine students wore FitBit smartwatches to track heart rates. The entire lesson was recorded and timestamped, and all participants filled out a questionnaire afterward. One lesson took place in a classroom with a traditional setup, while the other was held in a mobile classroom, where desks and chairs were equipped with wheels, allowing greater flexibility in movement and interaction.

The presentation will highlight several key dos and don'ts regarding procedures and methodology in this kind of research. Key topics will include:

- Recruiting and working with teachers and students for study participation.
- The logistics of conducting research on large groups of school children.
- The measurements and tools used to gather data.
- The study's ecological validity and its relevance to real-world classroom settings.
- Initial non-physiological results and reflections.
- Ideas for further data analysis and future directions in the research.

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**Kristina Klančič**

*Department of Psychology, University of Warsaw*

**Neuroaesthetics of classical ballet technique**

I am doing a master's thesis about the perception of ballet movement and its aesthetics. Ballet technique follows very specific universal rules and I want to see whether people watching dancers perform would notice the deviations from the technique and therefore perceive the movement as less aesthetic. I will conduct the research using prerecorded dance sequences with various levels of "perfection" and use eye tracking and questionnaire techniques to record data about the participants' perception.

**Agata Kochańska**

*Instytut Anglistyki UW*

**Social Pogos: On asymmetric patterns of mutual addressing**

Polish, just like many other languages (e.g. German or French), has at its disposal two parallel sets of address patterns: patterns which are characterized as signaling a certain degree of social distance between the interlocutors (such as Panie Dyrektorce; Herr Direktor in German) and patterns which are characterized as signaling no considerable social distance (such as given name address forms). The talk will focus on cases when the two interlocutors address each other, using patterns which, for whatever reason, are asymmetrical, that is, signal different degrees of social distance, as when S1 addresses S2 Panie Profesorze lit. 'Mr Professor', while S2 addresses S1 Agatko lit. 'AgataDIM. VOC.'. Specifically, the following issues will be considered: What contexts induce this asymmetry? What is its motivation? What interpersonal effects does this asymmetry bring about? What is the role of context in producing the relevant interpersonal effects?

**Lech Mankiewicz,**

*Center for Theoretical Physics, PAS*

**Why Does Our School Fail? A Reflection from a Physicist-Turned Teacher**

Five years ago, I was unexpectedly asked to become a private school's physics teacher for 7th and 8th graders. I was just concluding my role as director of the Center for Theoretical Physics at the time, so I felt well-prepared for a new challenge. Additionally, as chief editor of the Polish version of Khan Academy, I considered myself someone with authority in education, so I agreed.

Since then, my perspective on education has evolved. Traditional tools, such as numerical grades and compulsory homework, have proven ineffective, leading me to develop my methods. Furthermore, the curriculum seems misaligned with students' cognitive potential. In this talk, I will share my conservative approach to teaching and how I've adapted it over time to meet the realities of today's educational environment.

**Katarzyna Potęga vel Żabik**

*Centrum Nauki Kopernik*

### **Designing Collaborative Mechanics and Affordances in ORTHO game**

This workshop aims to explore how modifying the mechanics and affordances of the ORTHO game can enhance both individual and collaborative understanding of Cartesian coordinates. We will focus on integrating multi-player interaction (up to four participants) and adjusting game affordances to foster deeper engagement with the mathematical concepts at play.

ORTHO, conceptualized by Dor Abrahamson and featured in the LivingLab at the Copernicus Science Centre, is an interactive game designed to guide players from embodied, action-based manipulation to abstract, symbolic reasoning. Initially, two players physically control the movement of a ball along the x- and y-axes. As the game advances, they must increasingly rely on symbolic numerical coordinates to succeed. This transition between tangible manipulation and abstract understanding makes ORTHO a valuable tool for experiential learning.

The key challenge we aim to address in this workshop is how to adapt ORTHO's mechanics and affordances to promote more collaborative problem-solving and multi-player dynamics. We will explore how these changes can encourage players to apply Cartesian coordinates more purposefully rather than relying on trial and error. By adjusting feedback mechanisms, interaction patterns, and cooperative dynamics, we aim to deepen participants' mastery of both procedural knowledge (i.e., controlling and manipulating game elements) and conceptual knowledge (i.e., understanding and applying the coordinate system).

Workshop participants will collaborate to prototype and test new game mechanics. These designs will focus on fostering coordination between multiple players, potentially introducing new constraints that require players to work together to solve mathematical challenges. This shift in design aims to explore how cooperative engagement in game-based learning can further support the transition from embodied play to symbolic reasoning.

**Joanna Rączaszek-Leonardi**

*University of Warsaw*

### **Symbols in Social Interaction: back to Lew Wygotski (Lev Vygotsky)**

In the talk I recall Wygotski's "Tool and Symbol in Child's Development" (1930/1978/1991) and look at it from the point of view of modern theoretical needs. Is it true that "The origin of the symbolic forms of activity cannot be derived from (...) any other forms as long as we remain within the limits of individual psychology." (Wygotski, 1930/1978 p. 88)? What does it tell us about the symbols themselves and about collective (social) and individual (embodied and experienced) processes that underlie their origin and use? In asking these questions I hope for a discussion about the differences between symbolic processes in mathematics and in language and the implications for the use of both in human interaction.

**Katarzyna Skowrońska**

*University of Warsaw*

**Human or Bot? Investigating social engagement through an interactive computer game at the science centre exhibition**

In this presentation, I will discuss an experimental semiotic study conducted at the Copernicus Science Centre, which aimed to explore the minimal conditions required for the emergence of engagement in social interaction. The experiment involved a simple computer game in which participants controlled a virtual avatar and were asked to guess whether their in-game partner was a human player or a bot. The data collected included both behavioral metrics – players' movements within the game – and subjective reports on their experiences of first- and second-person engagement in interaction.

I will provide an overview of the study's methodology and experimental design, followed by a presentation of preliminary findings. Additionally, part of the talk will be devoted to discussing potential applications of the experiment in the form of an interactive exhibit, exploring how such research could be translated into an engaging experience for the science centre visitors.

**Jakub Strebeyko**

*HILL / UW*

**Dynamics at the verge of Knowledge: good intentions, bad actors and computational means of distinguishing the two on Wikipedia**

The talk offers an end-to-end perspective into Wikipedia's article revision process and the challenges it faces, especially in the advent of Generative AI. We will set up the stage with a primer into the platform's features that make it so valuable for natural language processing (NLP) needs. Useful as it is, though, Wikipedia's founding assumptions bring certain risks to the table we need to address. To get a better grip on the "how's" and "why's", we will deep dive into the harm that's already been done (and fixed!) in the past. What connects House Representatives, Indian Entrepreneurs and the right-wing bias in Croatian politics? With our imagination stimulated, we will examine the tools Wikimedia Foundation has at its disposal to flag ill will and ward off malicious revisions, vandalism and manipulation attempts. Which quirks of the platform make these efforts insufficient? The future is automatic, so our eyes will turn towards the next big thing. In search of neutrality guardrails, preventing us from drifting too far-off, we will explore the ways in which Large Language Models can aid the case. What's their promise? What could go wrong?

**Michał Weiss**

*University of Psychology*

**Quantifying movement coordination in Human-Robot Interaction**

We live in a time when robots are becoming an essential part of our daily lives. Engineers are working on developing robots (social and collaborative) with which humans will interact in various contexts, ranging from social to industrial settings. Consequently, there is a growing need to study the nature of these interactions. In my talk, I will present a method for evaluating such interactions by applying

Recurrence Quantification Analysis (RQA) to quantify motor coordination between a robot and a human during a simple assembly task performed in a VR environment.

**Natallia Valadzko**

*University of Warsaw*

### **The use of gesture in the medium of tabletop role-playing games**

Tabletop role-playing games – collaborative storytelling gamified – are a unique and understudied social and pragmatic context with several particularities that make them linguistically distinct from more traditional forms of narration. The Game Master (GM) oversees the players who roleplay as characters, and together they co-create a storyworld, which emerges in real time through their communication.

This presentation includes preliminary research that explores the interplay between gestures and spoken language in the medium of tabletop role-playing games. Using the multimodal data from the TRPG actual play show *Dimension 20*, several case studies are examined qualitatively. The analyses are conducted with the help of methods for Gesture Analysis (Müller, 2024) and cognitive linguistic oriented approaches to language and communication (e.g. Mental Space Theory, viewpoint phenomena).

The aim is to examine gesture dynamics in selected cases from several perspectives. Firstly, drawing insights from conversation analysis, gestures are analyzed as an integral part of social interaction. Hence, the question of how gestures participate in turn-taking, cooperative actions, and a range of embodied communicative activities is addressed. Secondly, looking at depictive gestures (e.g., as-if acting, as-if molding, as-if representing) unfolding within the discourse sheds light on the ways they may contribute to “stabilizing” conceptual structures of the imagined storyworld. Finally, since players co-exist together with their roleplayed characters, there arises the phenomenon of ‘split selves’ which gets represented both linguistically and gesturally. In relation to this, the issue of (non)immersed viewpoint is explored.

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**Julian Zubek**

*University of Warsaw*

### **Togetherness in Improvised Dance as a Process of Building Interpersonal Synergies**

Dance is a form of expression where human experience is expressed directly through movement. At the same time, it can be an occasion for a deep connection with another person, not mediated by language. In our study, we adopted a dance improvisation duet as a research framework that allows us to ask fundamental questions about the embodied dimension of the experience of togetherness. To this end, we videotaped eight improvised dance duets and then conducted video-cued interviews with the dancers. Based on the theory of participatory sense-making, we coded moments in the interviews when the dancers focused on their own process, the experience of the other person, and the common process taking place between the two people. We showed how, during the dance, a systemic perspective emerges from the first- and second-person perspectives. By juxtaposing the direction of the dancers' focus with their physical actions, we were able to show specific, embodied strategies for building a connection with the other person. We supplemented the picture with quantitative analyses based on motion tracking algorithms. We applied recurrence analysis methods to time series representing the movement of both dancers' hips and thus obtained a measure of the stability of interpersonal movement coordination over time. We observed a strong relation between the stability of movement coordination and the level of connection between the dancers assessed by external experts (average correlation coefficient 0.62). Our results are consistent with the adopted theory, which understands togetherness as a process of building interpersonal synergies, visible both at the level of first-person experience and third-person observation. This implies that the dancing individuals form a coordinated system, and their subjective experience of interaction is related to the functioning of this system.

**Konrad Zieliński**

*HILL/Uhura*

### **How can we transform: problem-focused radical transdisciplinarity combined with deep empathy, into a scientific method of communication, interaction or collaboration success?**

The Peripatetic Conference is a place to ask difficult questions and spark ideas that can transform our thinking about science and, in my case, its practical real-world applications. By showing the collaboration within the team of HILL and Uhura Bionics, as well as our interactions with external partners, and research participants, I hope I will be able to demonstrate the glance of an idea of radical transdisciplinarity focused on solving the real-life problems (in this case: with speech and communication) based on dejargonization of our internal and external communication, and inclusion of multiple perspectives in the design and collaborative processes. I will show a few case studies of communication successes and failures between researchers and research participants in order to ponder on how it can be improved, and assess whether there is a potential for “scientification” of our approaches.